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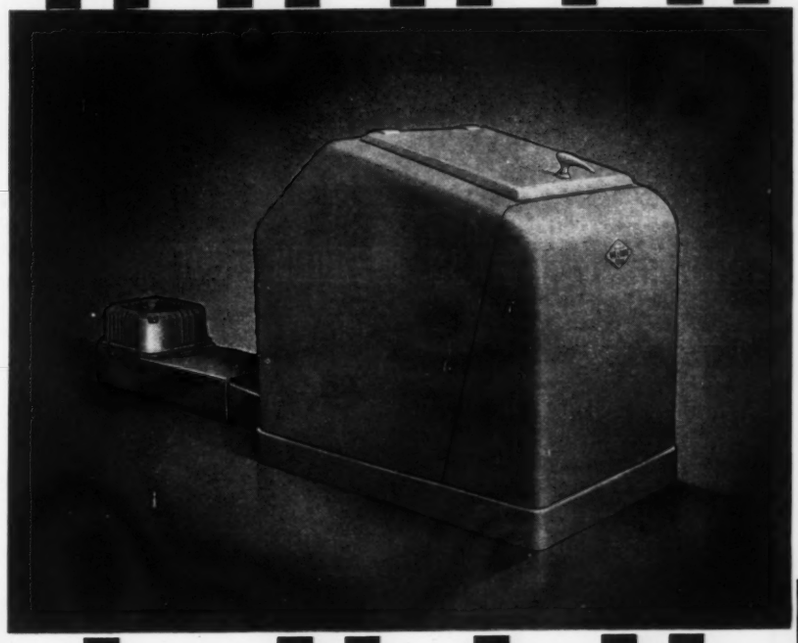
# MACHINE DESIGN



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*In This Issue*

**Materials Directory**

PARTS MATERIALS METHODS FINISHES

OF MACHINES OF EVERY SIZE AND TYPE

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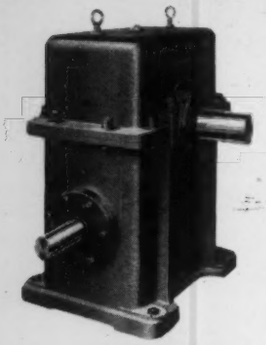
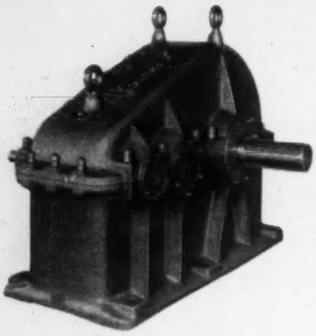
## MAKERS OF ALL TYPES OF SPEED REDUCERS AND CUT GEARS

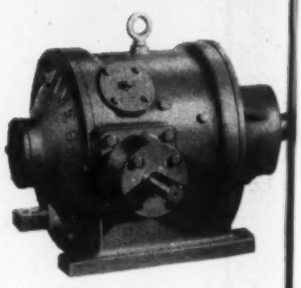


Heavy Duty Worm Gear Reducer
Horizontal Drive
Ratios 6 to 65:1 1/8 to 150 H. P.

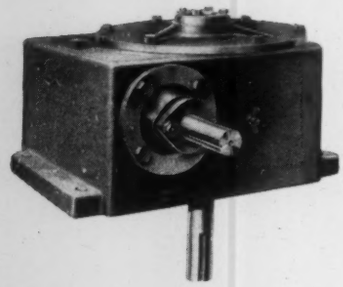


Continuous Tooth
Herringbone Reducer
Single, Double or Triple
Ratios 2 to 350:1 1 to 800 H. P.

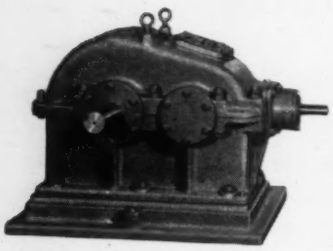
Planetary Gear Reducer
Horizontal or Vertical Drive
Ratios 4 to 1200:1 3/4 to 75 H. P.



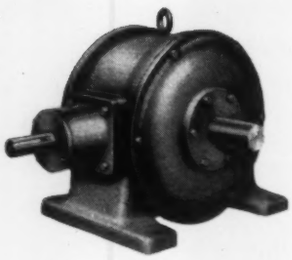
Right Angle
Spiral Bevel-Planetary Reduce
Horizontal Drive
Ratios 8 to 1200:1 3/4 to 50 H.P.



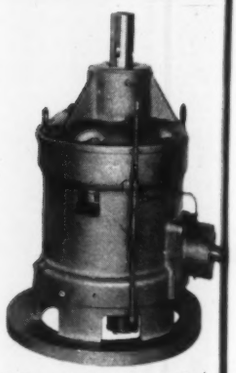
Heavy Duty Worm Gear Reducer
Vertical Drive
Ratios 6 to 65:1 1/8 to 150 H. P.



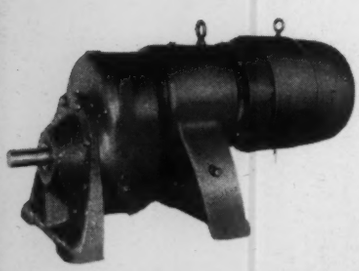
Right Angle
Spiral Bevel-Herringbone Reducer
Ratios 6 to 45:1 2 to 250 H. P.



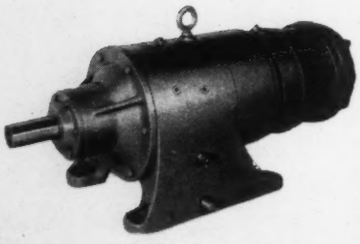
Right Angle Spiral Bevel
Gear Reducer
Horizontal or Vertical Drive
Ratios 1 to 6:1 3 to 275 H. P.



Spiral Bevel Planetary Reduce
Vertical Drive
Ratios 8 to 1200:1 3/4 to 50 H.P.

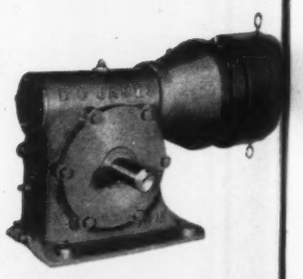


Motorized Helical Reducer
Horizontal or Vertical Drive
Ratios 1.2 to 9:1 3/4 to 50 H. P.



Motorized Planetary Reducer
Horizontal Drive
Ratios 4 to 1200:1 3/4 to 75 H. P.

Motorized Planetary Reducer
Vertical Drive
Ratios 4 to 1200:1 3/4 to 75 H. P.



Motorized Worm Gear Reduce
Horizontal or Vertical Drive
Ratios 6 to 80:1 1/8 to 50 H.P.

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# MACHINE DESIGN

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

Volume 12 — OCTOBER 1940 — Number 10


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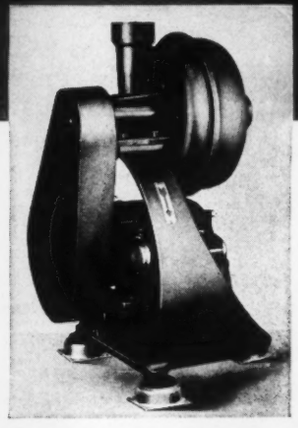


*"Sealed!"* is the title of an intensely interesting booklet describing the development and many uses of the self-sealed bearing pioneered by New Departure. Booklet D-5 free upon request. New Departure, Bristol, Conn.

# NEW DEPARTURE

## PIONEER OF THE SELF-SEALED BEARING

2925

MACHINE DESIGN

# Materials in Compressor Design

By Kenneth D. Moslander

HIGH strength steels as well as fatigue, corrosion and creep resistant alloys have their indispensable place in machine parts, fulfilling the functions for which they were developed. Good engineering design reserves them for these functions. Ready availability of high alloy steels and nonferrous alloys, however, frequently tempts the machine designer to go too far in their utilization. The result is usually an excellently engineered but all too often expensive piece of equipment, however satisfactory from the standpoints of oper-

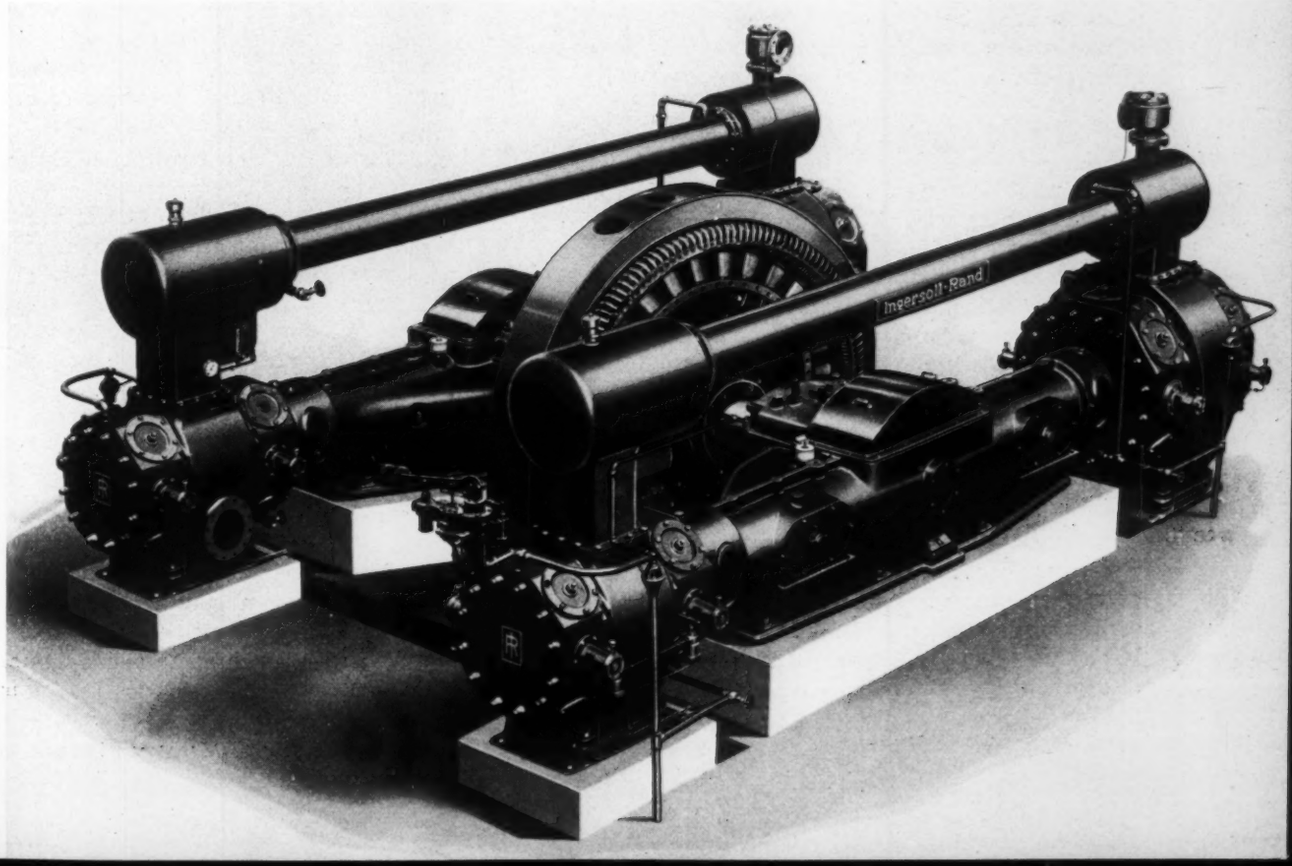



Fig. 1—Four-corner duplex compressor illustrates the trend toward in-line load members

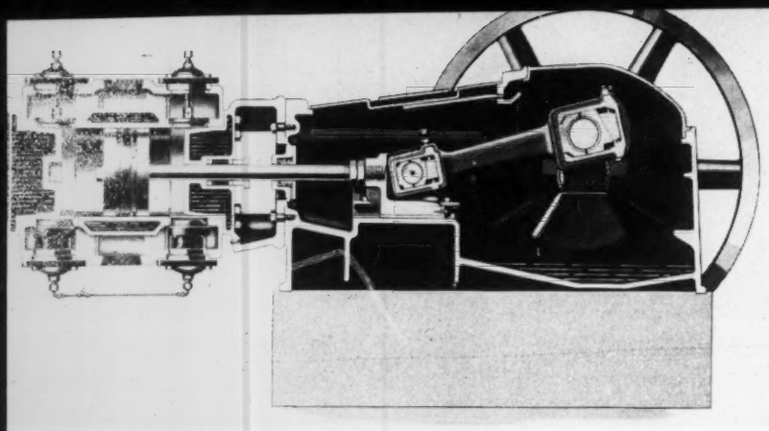


Fig. 2—Wedge adjusted bearing assembly is shown in this compressor designed to work without lubrication

ation and mechanical maintenance it may be.

Overdesigning for materials is as serious an error as overdesigning for strength. When space and weight limitations are not too restrictive a careful consideration of the applicability of gray cast iron, semisteel, cast and mild forged steels will pay dividends in reduced manufacturing costs. Manifold applications of refined alloys to unusually severe service should serve but to supplement the functions of mild carbon steel and gray iron castings.

Typifying the economy resulting from such judicious materials specifications without sacrificing sound mechanical design, stationary air and gas compressors are an excellent example of the manner in which conventional materials may be used advantageously.

Foundry metallurgy is capable of providing a wide variety of cast iron alloys, affording as many as eight special iron mixtures for various component parts of the compressor. Modern foundries, in order to handle small melts of these special mixes, usually employ a small electric cupola in which the exact mixtures can more easily be controlled than in the main foundry cupolas.

Avoidance of shapes and contours which would result in high stress concentrations permits the use of gray iron castings for machine frames. The improved appearance of the compressors shown in *Figs.* 1 and 2 in comparison with older "pedestal" types is in large measure attributable to such design considerations.

## Valves Are High Alloy Steel

At the other extreme, compressor valves represent the ultimate in special alloys, specially heat treated and finished. "Channel" type valves shown in *Fig.* 3 must possess maximum resistance to wear and corrosion. In addition, the channels, the sealing members of this valve, must have high strength and rigidity. For these parts high chrome-nickel steel is used. Precise heat treating specifications are stipulated; dimension and finish are carefully controlled. The leaf spring, which by its fit between the flanges of the channel provides a trapped air pocket to cushion the valve, is stainless spring steel.

"Feather" type valves are similar in design and close control of materials and finish. This type, however, does not use a channel. The surfaces of the leaf springs are ground after heat treating and seal directly on the valve seat. Impact stresses in this valve are also practically eliminated since, as the valve closes, the spring strips contact the seating surface progressively from each end.

Another valve design employs one or more stainless steel, spring-loaded annular disks hardened and ground. Several variations of this design are in use. Separate annular rings, each loaded by three or more helical springs seated in the valve guard is one modification. Another employs one plate with two or more annular slots. This design permits the use of only one spring. Extreme care is used in selecting material to resist warping as well as to maintain a polished surface under the erosive effect of high pressure gas. The keepers or guards are maintained somewhat softer than the disks.

Between the extremes of frame and valves are the materials used in the other parts of the compressors, each representing the most economical and yet adequate answer to the operating requirements. Cylinders and heads are alloy cast iron for pressures below ap-

Fig. 3—Channel type valve provides air pocket cushioning

proximately 1000 pounds per square inch. Cast or forged steel is used for higher pressures. When steel forgings are used it is, of course, necessary to build the water jackets around the cylinder rather than cast integrally with it as when made from cast steel or iron.

Particularly in high pressure (3500 to 4500 pounds per square inch) compressors, removable cylinder liners are sometimes used. Nickel alloy iron castings are employed for these liners, which are rough turned and pressed into position before being finish bored. The facility of this material for acquiring a surface glaze in a short "running in" period obviates the necessity of grinding or honing the cylinder walls.

Cast semisteel cylinders and heads as employed by one manufacturer of medium pressure compressors have a typical composition of 35.0 per cent steel, 1.45 per cent silicon, 1.2 per cent phosphorus, .09 per cent sulphur, .79 per cent manganese, 3.2 per cent total carbon, .45 per cent nickel, .28 per cent chromium.

Physical properties of this material are controlled by specifying a minimum ultimate transverse load of 4615 pounds concentrated on a 1¼-inch diameter bar supported on 12 inch centers; maximum deflection is held at .18-inch. An empirical relationship between

this load and the ultimate stress in pure tension has been determined to be: Transverse load $\times$ 10 = Ultimate tensile stress. On this basis, the ultimate stress of this semisteel casting would be approximately 46,150 pounds per square inch.

*Fig.* 4 shows a drawing of the running gear including crossheads, main bearing, slippers and piston rods. The tierods incorporated in the dual crosshead design, while making possible the operation of two opposed cylinders with but one connecting rod, are chiefly utilized to maintain all piston rod strains in exactly the same line with the connecting rod.

Materials used in the reciprocating running gear are

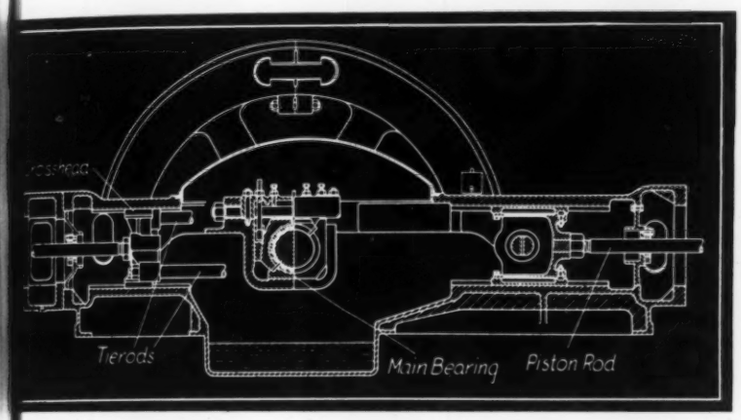



**Fig. 4—Connecting rod drives crosshead on right directly in this running gear assembly**

selected to maintain inertia loads at a minimum while providing adequate strength for high pressure service. Hollow ribbed construction of the cast semisteel pistons fulfill these requirements. Two cast iron rings of the three-piece type are used, each with a single internal expanding ring. In service where lubrication is not feasible, graphitic carbon rings are employed in a honed cast iron cylinder, as shown in *Fig.* 2. In this case, three rings are used; two for sealing and a third wider ring, spaced midway between the sealing rings, to carry the piston load on the cylinder walls. In oil refinery service where difficult lubrication or corrosive conditions may exist, micarta rings are sometimes utilized.

Piston rods shown in *Fig.* 4 must be sufficiently rigid to withstand the slender column effect of axial loading and, at the same time, resist scoring in passing through the stuffing box. Tough cored, casehardened carbon steel ground and polished is used for this service. In special applications where the rods are exposed to corrosive conditions, stainless steel similarly treated and finished is used.

Connecting rods and crankshafts are one-piece die forgings. The former are forged from large billets to insure adequate working of the material in the one-piece closed end sections, after which they are heat treated and stress relieved.

Open hearth S. A. E. 1045 steel with a tensile strength of 85,000 pounds per square inch, an elastic limit of 60,000 pounds per square inch and a minimum reduction of area of 45 per cent is a satisfactory material for these parts.

## Bearings Safeguard Motor

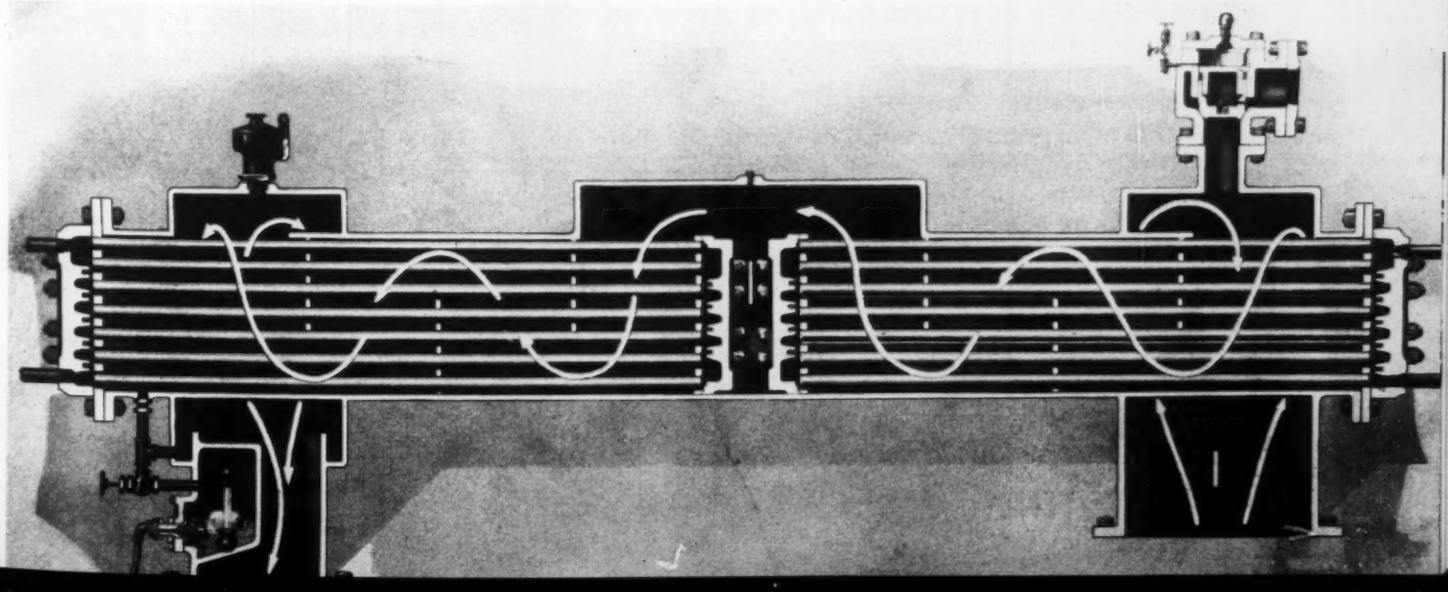
When the compressors are directly connected to the driving motor as shown in *Fig.* 1, the design of, and the materials used for the main bearings are exceptionally important. Whereas tapered roller bearings are sometimes used, plain bearings are more common. These bearings, shown in *Figs.* 2 and 4, are of the split, wedge adjustable type. Excessive wear of the bearings through faulty lubrication or the like, in addition to possibly damaging the crankshaft, might cause the driving motor rotor to shift and interfere with the stator. To safeguard against this possibility, leaded bronze sleeves are pressed into the cast iron bearing housings. A thin, centrifugally cast babbitt liner is then applied inside the leaded bronze sleeve. Thus if the babbitt bearing fails, the shaft will run on the leaded bronze without danger to the crank or motor until the babbitt bearing is replaced.

Intercoolers used between the stages of compression not only improve compression efficiency but also, because of the lower compression temperatures, afford better lubrication, minimize carbonization and tend to precipitate entrained moisture.

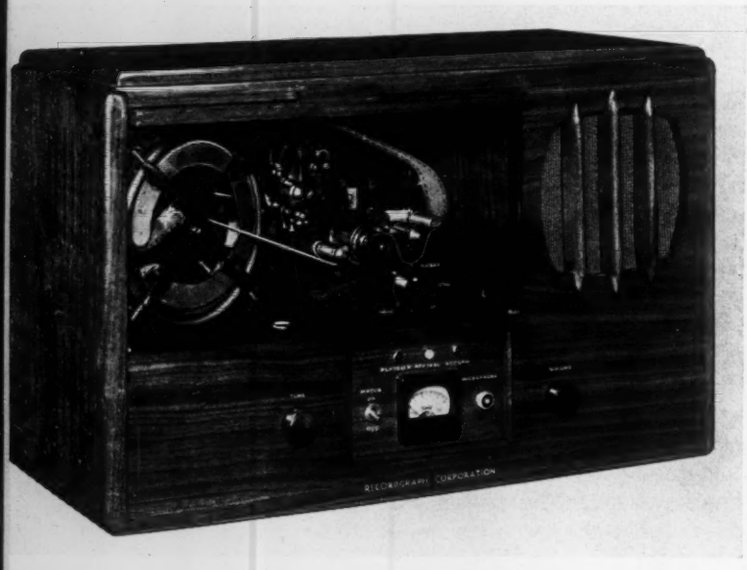
Intercoolers shown in *Fig.* 5 are of the shell and

(*Concluded on Page* 104)

**Fig. 5—Intercooler design permits easy removal of cooling water tube nests, thus facilitating cleaning**



# Scanning the Field FOR IDEAS




**Remote, semiautomatic operation** has proved its advantages for many types of applications. Besides better control and convenience, economies effected usually justify the additional equipment necessary. A typical example is an arc welder where it is advantageous to control the generator from operator's position.

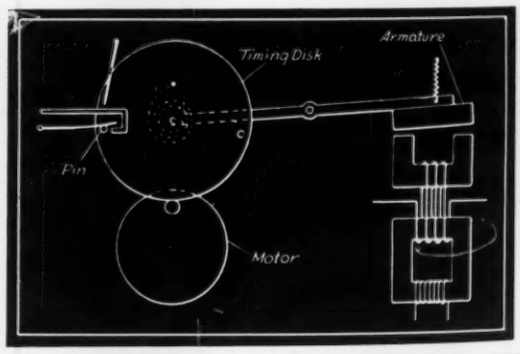
Developed by Wilson Welder and Metals Co. Inc. the automatic start and stop device illustrated below is controlled by grounding the electrode to the work. When the generator is not running, a transformer provides a small auxiliary voltage to operate a relay. A secondary coil embraces the transformer and relay core. Closing the circuit excites the relay and pulls in an armature. At the same time a disk of a timing motor is released and turned counterclockwise, closing contacts for the generator starter.

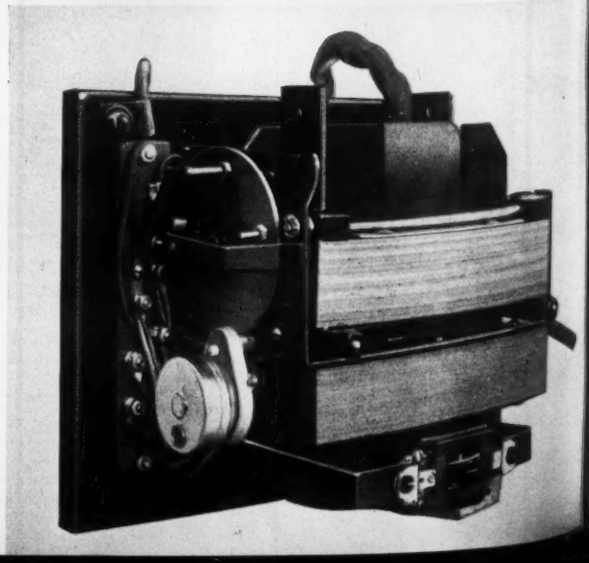
When operation is interrupted the armature is released and the timing disk is swung into engagement with the timing motor. The required delayed operation is provided by the position of the pin shown.

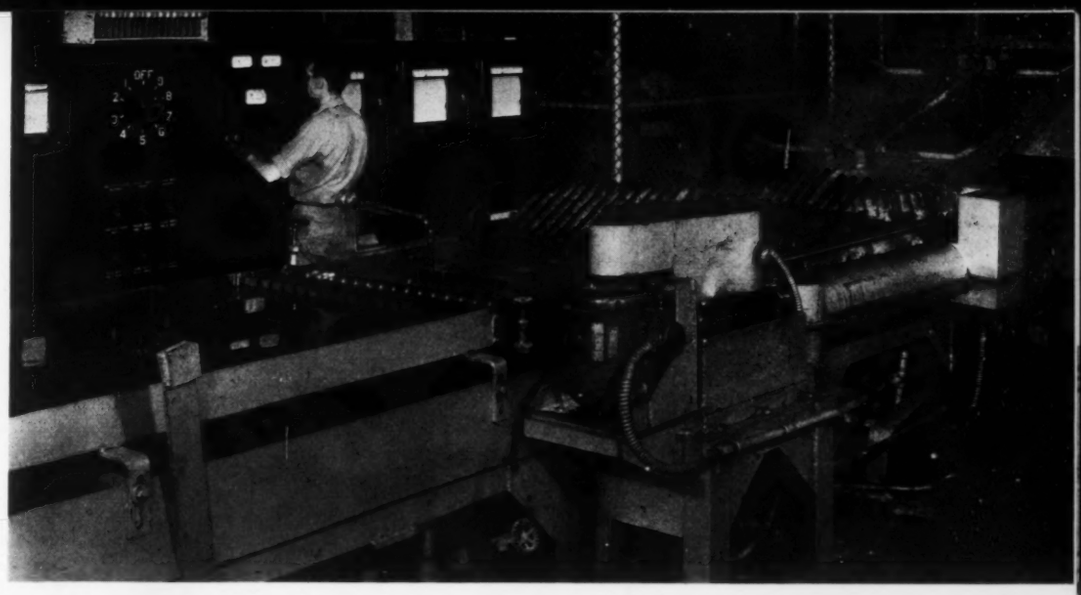
**Continuous operation** of machines employing an endless loop such as display movie projectors and sound recorders often presents a problem in winding equal lengths on and off a reel. The differential between the interior and exterior diameters of the reel imposes design barriers which have in the past been difficult to solve.

In the machine (above) designed by Recordgraph Corp., two provisions overcome this difficulty. Friction from the magazine is negligible because it is fitted with rollers running on small bearings associated with felt oil washers. Also, the film is treated by a simple and inexpensive process which reduces the friction between each layer of film.

In operation the propelling roller pulls the film from the inside. If it were free to do so, the outer diameter would take up more film proportionate to the number of turns on the reel and would overtake any amount of slack originally provided. The attempt, however to take up more film than given up causes the film to try to run faster than the supply permits. This tendency to go ahead rather than to retard allows the rolls to run loosely. Layers of film hardly touch at the bottom but lie on each other at the top of the reel. The motion of the rollers permits the various layers to slip slightly and compensates for the difference in circumference of the respective layers of film.



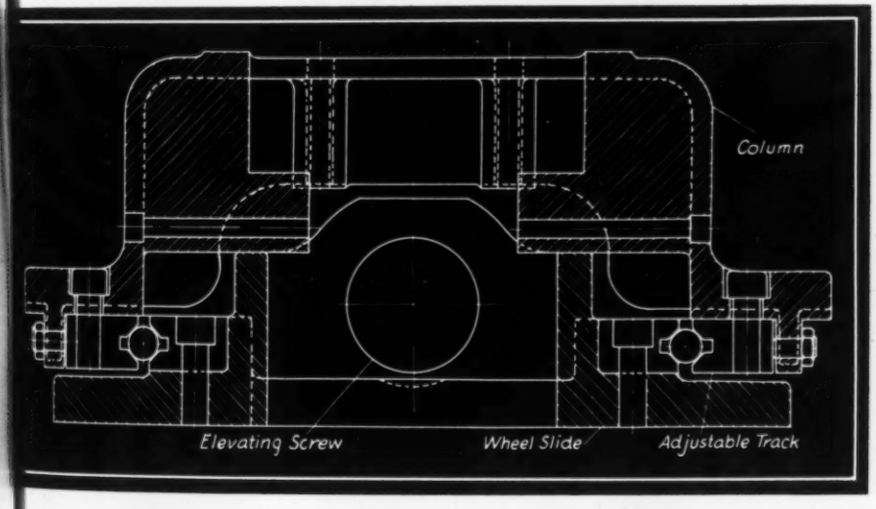





**New methods of heat treating** are providing better and more economical machine parts for the designer. One of the latest developments of this type is a continuous process developed by Jones and Laughlin Steel Corp. for heat treating steel spring wire through utilizing its electrical resistance. Similar to the principle of heating the wires in a domestic toaster, resistance to flow of current heats the wire being treated. In this way the full cross sectional area of the wire is heated simultaneously.

In process, the wire is fed through two molten electrical contacts. These contacts are held at constant predetermined temperatures and the wire between is heated by the current passing through. The second contact serves also as a primary quenching bath providing double-phase quenching with an oil bath. Continuing from the final quench to a tempering bath, the wire is reheated to give it the desired physical properties and fatigue values. Thermocouples in all contact, quench and temper baths provide automatic control.

Advantages include holding of the process decarburization and scaling to narrow limits by keeping all the heat within the spring wire itself as well as providing close control of the properties of the wire by precise regulation of time and temperatures of treatment.

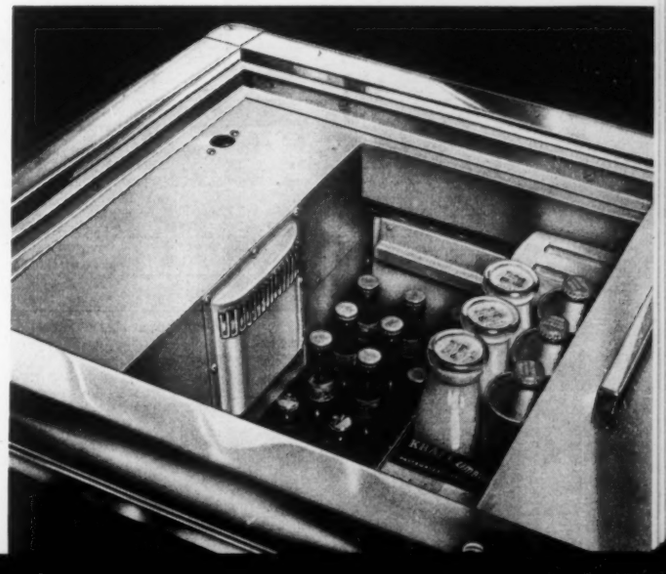



**Preloaded bearings** have been utilized widely in applications requiring high accuracy. An interesting extension of this idea is illustrated in the above drawing of a vertical ball bearing slide as employed on Taft-Peirce precision grinders. The slide assembly carrying the grinding wheel spindle weighs nearly 300 pounds, yet is easily and accurately controlled by an elevating screw. Balls are spaced in the slide by suitable retainers.

Careful adjustment of tension on the movable column guides provides accurate and uniform motion of the slide. This construction also overcomes difficulties which may arise from variations in the temperature, oil film or wear. Slides are hardened and ground high chrome carbon molybdenum tool steel, so mounted that they can be restored quickly by regrinding if at any time it should become necessary.

**Utilizing dry air** as the heat exchange medium instead of water as formerly, Crosley bottle cooler (below) has combined the advantages of domestic refrigerators and unit air-conditioning systems. Sanitary, efficient cooling is provided in this way.

Forced dry air blasts circulating through cabinet and evaporator coils provide ample cooling capacity. Compressor unit is hermetically sealed in a steel jacket and employs Freon refrigerant. Insulation, also, is sealed against moisture absorption.



# Spring Materials

By A. M. Wahl
*Westinghouse Electric & Mfg. Co.*

MACHINE designers frequently are called upon to apply springs which are subject to repeated or fatigue loading. The spring property of most importance in the selection and design of such springs is the endurance limit of the spring material for the range of stress under consideration. Presented in convenient form in this article is a summary of available data on endurance ranges of helical and leaf springs and spring materials to aid the designer in making an intelligent selection of the proper spring for a particular application.

A survey of the literature indicates that there are con-

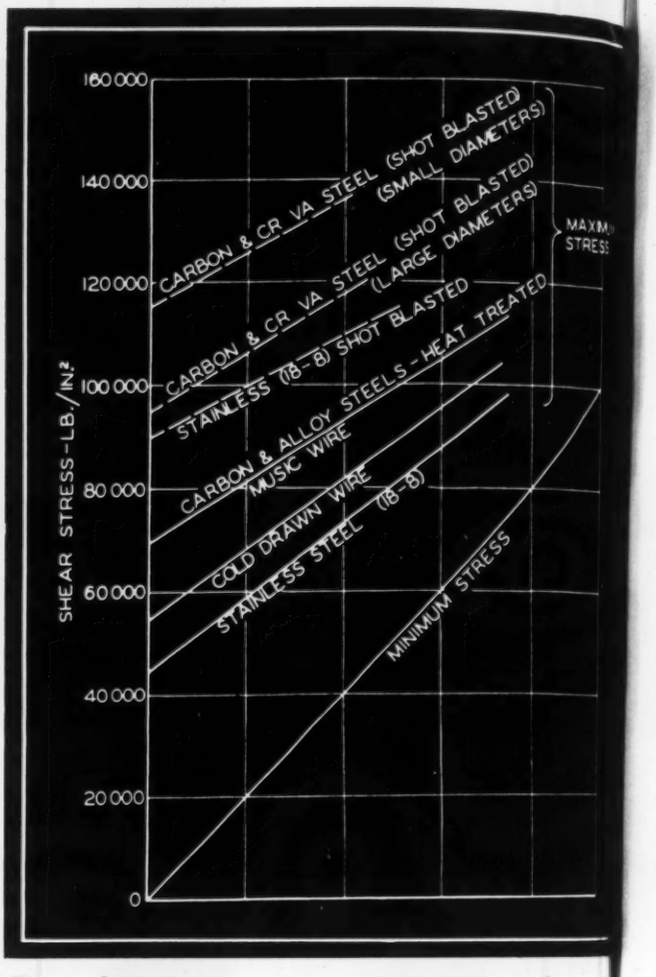



**Fig. 1—Approximate endurance diagrams for good quality helical springs. All stresses are figured by using curvature correction factor *K*. For springs with exceptionally large indexes the actual values may be somewhat lower. Limiting stress range is read vertically between line of minimum stress and lines for each material representing maximum stress**

TABLE I

**Endurance Limits and Physical Properties of Spring Materials in Torsion**

| Material | Specimen or Wire Dia. inches | Heat Treatment | Condition of Surface | Hardness | Ult. Strength (Tension) lb./sq. in. | Yield Point (Tension) lb./sq. in. | Mod. of Rupture (Torsion) lb./sq. in. | Yield Point (Torsion)** lb./sq. in. | Limiting Endurance Range in Torsion§ lb./sq. in. | Investigator |
|---|---|---|---|---|---|---|---|---|---|---|
| Tempered Swedish Steel Wire | .125 | | As received | 45 Rock. C | 226,000 | 203,000 | 166,000 | 139,000 | 0 to 110,000* | Weibel[1] |
| .60% C | .187 | | " | 43 Rock. C | 211,000 | 190,000 | 162,000 | 125,000 | 0 to 107,000* | " |
| .35% Mn (approx.) | .225 | | " | 42 Rock. C | 204,000 | 181,000 | 166,000 | 120,000 | ±56,000<br>0 to 100,000* | " |
| .6% C Spring Steel | .13† | O.Q. 950 C<br>T. 500°C | Ground and polished | 365 Brinell | 177,000 | 161,000 | 150,000 | | ±52600<br>4500 to 103,000<br>55000 to 125,000 | Hankins[2] |
| Cr Va Spring Steel | .13† | O.Q. 850°C<br>T. 600°C | Ground and polished | 385 Brinell | 177,000 | 168,000 | 148,000 | | ±56000<br>10000 to 111,000<br>57000 to 131,000 | Hankins[2] |
| Cold Drawn Steel Wire | .160 | | As received | 350 Brinell | 202,000 | | 155,000 | | ±36400†† | Lea and Dick[3] |
| High Carbon O.H. Steel .91% C .38% Mn | .25 | O.Q. 1575°F<br>D. 940°F | Ground and polished | 438-450 Brinell | 225,000 | 179,000 | 173,000 | 118,000 | ±52000<br>0 to 102,000 | Johnson[4] |
| Cr Va Electric .52% C .88% Cr .21% Va | .25 | O.Q. 1600°F<br>D. 810°F | Ground and polished | 477-488 Brinell | 237,000 | 229,000 | 183,000 | 141,000 | ±75000<br>0 to 128,000 | Johnson[4] |
| High Carbon Electric Steel | .25 | O.Q. 1550°F<br>D. 800°F | Ground and polished | 430-470 Brinell | 237,000 | 194,000 | 194,000 | 126,000 | 0 to 123,000 | Johnson[4] |
| Beryllium Bronze | .25 | | | 303 Brinell | 166,000 | 132,000 | 110,000 | 95,000 | ±16000<br>0 to 30,000 | Johnson[4] |

* These figures probably represent ideal conditions when no flaws are present.
** Based on .2% plastic strain.
† Specimen turned down to this diameter.
†† Low value attributed by investigators to defects set up by drawing operation.
§ Where more than one figure is listed for a given material, this means that tests were made at different stress ranges, i.e., ± or completely reversed stress, 0 to maximum, or intermediate to maximum stress as indicated

1 *Trans. A.S.M.E.*, Nov. 1935, p. 501.
2 *Eng. Research Special Report* No. 9, Dept. of Scientific & Industrial Research (British).
3 *Proc. Inst. Mech. Engrs.* 1931, p. 661.
4 *Iron Age*, March 15, 1934, p. 12.

TABLE II

## Limiting Endurance Ranges of Helical Compression Springs*

| Coil Dia. D inches | Wire Dia. d inches | Index D/d | No. of Active Coils | Material | Heat Treatment§ | Hardness | Modulus of Rupture (Torsion) lb./sq. in. | Elastic Limit or Yield Point (Torsion) lb./sq. in. | Ultimate Strength (Tension) lb./sq. in. | Limiting Endurance Range§§ lb./sq. in. | Investigator |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.7 | 16 | 10.6 | | Cold Drawn Wire | | | 155000 | | 202000 | 25000 to 56000** | Lea and Dick[1] |
| 1.5 | 128 | 11.7 | | C.D. Wire .63% C | | 360 Brinell | 143000 | | 184000 | 25000 to 66000** | " |
| 1.087 | 163 | 6.67 | 6 | C.D. Wire .93% C | | 51 Rock. C | 216000 | 118000 E.L. | 282000 | 20000 to 80000<br>40000 to 95000 | Zimmerli[2]††† |
| 1.10 | .148 | 7.44 | 6 | Pretempered Wire<br>.65% C<br>.64% Mn | | 43 Rock. C | 184000 | 110000 E.L. | 203000 | 20000 to 72000<br>40000 to 85000<br>60000 to 98000 | " |
| 1.10 | .148 | 7.44 | 6 | Cr Va Steel<br>1.12% Cr<br>.12% Va | O.Q. 1650°F<br>D 900°F | 41 Rock. C | 152000 | 107000 E.L. | 202000 | 12000 to 84000<br>23000 to 92000<br>50000 to 105000 | " |
| 1.10 | .148 | 7.44 | 6 | Pretempered Wire<br>.75% C<br>.32% Mn | Blued at 475°F for 20 minutes | 44 Rock. C | 180000 | 111000 E.L. | 216000 | 20000 to 80000<br>40000 to 92000<br>60000 to 105000 | " |
| 1.10 | .147 | 7.5 | 6 | Stainless Steel<br>17.4% Cr<br>8.9% Ni | Blued at 700°F 25 min. after winding | 42 Rock. C | 172000 | | 216000 | 20000 to 45000<br>40000 to 62000<br>60000 to 79000 | " |
| 1.06 | .162 | 6.5 | 3¾ | Valve Spring Wire<br>.65% C<br>.58% Mn | Heated to 750°F after coiling | | | | 204000 | 20000 to 95000<br>20000 to 135000† | Zimmerli[3]††† |
| | .148 | 6-7 | | Music Wire SAE 1095 and Cr Va SAE 6150 | | | | | | 20000 to 90000<br>20000 to 135000† | " |
| | .148 | 6-7 | | Stainless Steel 18-8 | | | | | | 20000 to 65000<br>20000 to 110000† | " |
| | .148 | 6-7 | | Phosphor Bronze SAE 81 | | | | | | 20000 to 35000<br>20000 to 50000† | " |
| 2.69 | .56 | 4.8 | 6½ | Cr Va Steel<br>.52%C .88% Cr<br>.21% Va | Wound hot<br>O.Q. 1600°F<br>D. 810°F | 477-488 Brinell | 183000 | 141000 Y.P. | 237000 | 0 to 77000‡ | Johnson[4]*** |
| 2.69 | .56 | 4.8 | 6½ | High Carbon Electric Steel<br>1.04% C<br>.36% Mn | Wound cold | 430-470 Brinell | 194000 | 126000 Y.P. | 237000 | 0 to 93000‡ | " |
| 2.69 | .56 | 4.8 | 6½ | High Carbon Open Hearth Steel<br>.91% C<br>.38% Mn | Wound hot<br>O.Q. 1575°F<br>D. 940°F | 438-450 Brinell | 173000 | 118000 Y.P. | 225000 | 0 to 68000‡ | " |
| 2.69 | .56 | 4.8 | 6½ | Beryllium Bronze<br>Be 97.60%<br>Cu 2.38% | Wound cold<br>Heated 2 hrs. at 520°F after coiling. | 303 Brinell | 110000 | 95000 Y.P. | 166000 | 0 to 33000‡ | " |
| 3.75 | ¾ | 5 | 7½ | Carbon<br>O.H. Steel<br>1.05% C<br>.36% Mn | Wound hot<br>O.Q. 1620°F<br>D. 700°F | | 153100 | 119000 Y.P. | 206200 | 0 to 72700 | Edgerton[5] |
| 2.25 | ¾ | 3 | 7½ | " | " | | 153100 | 119000 Y.P. | 206200 | 0 to 92200 | " |
| 3.75 | ¾ | 5 | 7½ | Carbon Electric Steel<br>1.05% C<br>.21% Mn | Hot wound<br>O.Q. 1640°F<br>D. 700°F | | 164200 | 94500 Y.P. | 205200 | 0 to 58200†† | " |
| 3.75 | ¾ | 5 | 7½ | Silicon Vanadium Steel<br>.63% Si<br>.17% Va | Hot wound<br>O.Q. 1570°F<br>D. 850°F | | 175000 | 129000 Y.P. | 205000 | 0 to 62800 | " |
| 3.75 | ¾ | 5 | 7½ | Carbon Electric Steel | Hot wound<br>O.Q. 1550°F<br>D. 850°F | | 171000 | 129000 Y.P. | 200600 | 0 to 75600 | " |
| 1⅜ | .135 | 14 | | Valve Spring Carbon Steel<br>.63% C<br>.72% Mn | Q. 1650°F<br>D. 900°F<br>Wound cold<br>Heated at 600°F | 43 Rock. C | 171000 | 98000 E.L. | 214000 | 0 to 68000<br>20000 to 86000<br>40000 to 105000 | Tatnall[6] |
| 1⅜ | .135 | 14 | | Commercial Carbon Steel<br>.50% C<br>.89% Mn | Q. 1650°F<br>D. 800°F | 44.5 Rock. C | 178000 | 107000 E.L. | 228000 | 0 to 53000<br>20000 to 70000<br>40000 to 85000 | " |
| 1⅜ | .135 | 14 | | Cold Drawn Commercial Carbon Steel | | 30 Rock. C | 145000 | | 191000 | 0 to 46000<br>40000 to 85000 | " |
| .437 | .063 | 7 | | Music Wire | Cold Wound Heated at 500-535°F after winding | | | | | 0 to 76000 | Hengstenberg[7] |
| 1.9 | .225 | 8.4 | | " | " | | | | | 0 to 65000 | " |
| 1.75 | .250 | 7 | | " | " | | | | | 0 to 56900 | " |
| 1.77 | .225 | 7.9 | | Electric Carbon Steel<br>.8-.95% C<br>.5% Mn | Heat treated after forming | 390-425 Brinell | | | | 0 to 69000 | " |
| 2.0 | .250 | 8 | | Carbon Steel<br>.55-.7% C<br>.9-1.2% Mn | Cold wound<br>Heated at 500-535°F after winding | | | | | 0 to 56000 | " |

* All stress values corrected for bar curvature and direct shear by multiplying by stress correction factor $K$. All values refer to compression springs except where otherwise noted.

** Low values attributed to surface injury due to drawing. Tension springs used in these tests.

*** No cracks shown by magnaflux test of springs.

§ Q. and D. = quenched and drawn; O.Q. = oil quenched; C.D. = cold drawn.

† After shot-blasting.

‡ These values estimated for $10^7$ cycles. Actual tests run to $10^6$ cycles only.

†† Low value probably due to incorrect heat-treatment.

††† In all of Zimmerli's tests wire showing surface defects was rejected.

§§ Where more than one stress range is listed for a given material these correspond approximately in most cases to actual stress ranges used in the tests. Thus, for example, in the fifth row of the table, for CrVa spring steel, tests showed that springs of this material will withstand indefinitely a stress range from 12,000 to 84,000, from 23,000 to 92,000 or from 50,000 to 105,000 lb./sq. in. From these figures endurance diagrams similar to *Fig.* 1 may be drawn.

1 *Proc. Inst. Mech. Engrs.*, Vol. 120, 1931, p. 661.
2 *Univ. of Michigan Engineering Research Bul.* No. 26.
3 Paper to be published in *Trans. A.S.M.*
4 *Iron Age*, March 15, 1934, p. 12.
5 *Trans. A.S.M.E.*, Oct. 1937, p. 609.
6 *Wire and Wire Products*, Oct. 1937, p. 577.
7 Tests carried out at Westinghouse Research Laboratories.

TABLE III

**Summary of Limiting Stress Ranges Small-Size Helical Springs***

(Assuming Range from Minimum Stress Near Zero)

| Material | Approx. Wire Dia. inches | Index D/d | Limiting Stress Range§ lb./sq. in. | Investigator |
|---|---|---|---|---|
| Cold Drawn Wire | .13-.16 | 10-11 | 41000**<br>31000** | Lea & Dick |
| | .16 | 6 | 60000 | Zimmerli |
| | .135 | 14 | 46000 | Tatnall |
| Music Wire | .25 | 8 | 56000 | Hengstenberg |
| | .063 | 7 | 76000 | " |
| | .148 | 6-7 | 70000 | Zimmerli |
| | .148 | 6-7 | 115000† | " |
| Valve Spring Wire .65% C | .162 | 6.5 | 75000 | " |
| | | | 115000† | " |
| | .135 | 14 | 68000 | Tatnall |
| Carbon Steel Wire (Cold Wound) | .148 | 7.4 | 60000 | Zimmerli |
| | .148 | 7.4 | 52000 | " |
| | .135 | 14 | 53000 | Tatnall |
| | .25 | 8 | 56000 | Hengstenberg |
| Cr Va Steel SAE 6150 | .148 | 7.4 | 70000 | Zimmerli |
| | | | 115000† | " |
| Stainless Steel 18-8 | .148 | 6-7 | 45000 | " |
| | | | 90000† | " |
| Phos. Bronze SAE 81 | .148 | 6-7 | 15000 | " |
| | | | 30000† | " |

* Values computed by using factor $K$ to take into account bar curvature and direct shear. Compression springs used except where noted.
† Shot blasted.
** Values obtained on tension springs.
§ Maximum stress of range found by adding minimum stress to stress range given in this column. Thus for CrVa steel range might be 0 to 70,000, 5000 to 75,000, or 10,000 to 80,000 lb./sq. in. Variations in range listed for the same type of material may be due to differences in quality of material or to differences in spring index or wire size.

siderable differences in the endurance limits or limiting stress ranges reported by different investigators even for the same or similar materials. The reason for this lies mainly in the fact that the endurance limit is very much dependent on the surface condition of the spring wire or bar. Slight surface flaws or defects produced in manufacture may result in a considerable reduction of the limiting endurance range. The low values reported in some cases may be due to this.

Results of tests on spring materials in torsion and on helical compression springs (also subject principally to torsion stress) are tabulated in TABLES I, II, III and IV. Pertinent data including kind of material, heat treatment, surface condition (i.e., whether ground and polished or untouched), ultimate and yield strengths in tension, modulus of rupture and yield strength in torsion, and literature reference are given together with the limiting endurance range values. Thus a range from 0 to 110,000 pounds per square inch means that according to the tests the spring or bar will withstand a range of torsion stress between these limits indefinitely. Completely reversed torsion stress is indicated by the $\pm$ sign.

In the group of figures for .6 per cent carbon spring steel in TABLE I, the figure $\pm$52,600 pounds per square inch in the column under limiting endurance range in torsion means the specimen will withstand indefinitely a completely reversed stress of this value. In the same group of figures, 4500 to 103,000 and 55,000 to 125,000 indicate limiting ranges tested by the investigator. Similar tabulations are used in the other tables.

Values of limiting torsion stress range for helical springs as given in TABLES II, III and IV have been computed by using a factor $K$ to take into account effects of bar curvature and direct shear. In addition, on these tables, data pertaining to material, size of wire, coil diameter, spring index, number of coils, hardness, physical properties in tension and torsion are given together with the source. TABLE II contains fairly complete data on various tests.

TABLE III gives a summary of the expected limiting stress range assuming a low minimum stress, say 10,000-20,000 pounds per square inch, as estimated from data given in TABLE II on springs of the smaller sized wire. Thus the limiting stress range of 60,000 for cold wound carbon steel wire means the spring will withstand a total range of 60,000 pounds per square inch from a low minimum stress, 0 to 60,000, 5000 to 65,000, or 10,000 to 70,000. The figures in each group refer to results as estimated from tests reported by different investigators.

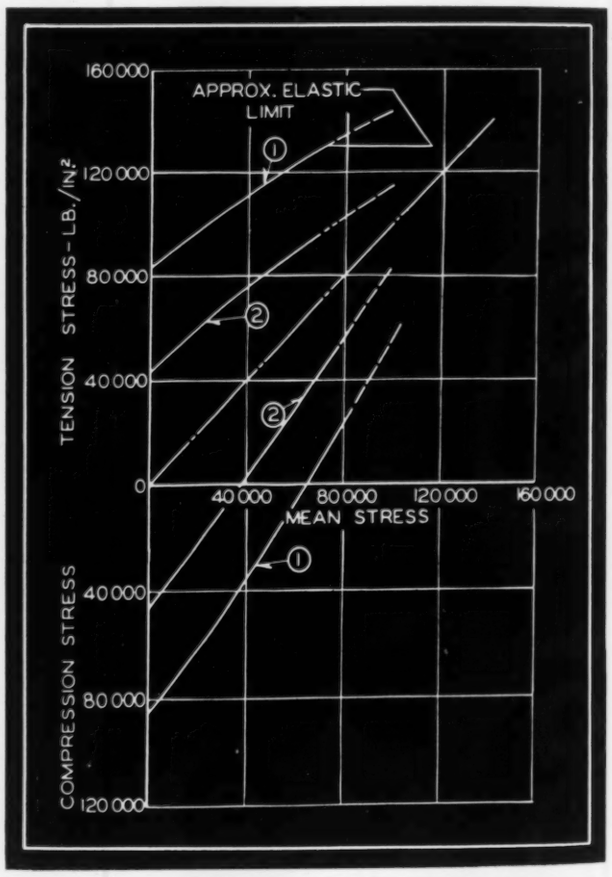



**Fig. 2—Approximate endurance diagrams for good quality leaf and plate spring materials. Curves (1) are for surfaces ground and polished after heat treatment, curves (2) for surfaces unmachined after heat treatment**

Quality of the material tested, however, is not necessarily the same while wire size and spring index also are different. These factors account for the fact

TABLE IV

**Summary of Limiting Stress Ranges Larger-sized Helical Compression Springs***

(Minimum Stress Near Zero)

| Material | Approx. Bar Dia. Inches | Index D/d | Limiting Stress Range§ lb./sq. in. | Investigator |
|---|---|---|---|---|
| O.H. Carbon Steel | .56 | 4.8 | 68000 | Johnson |
| | ¾ | 5 | 72700 | Edgerton |
| Cr Vanadium Steel | .56 | 4.8 | 77000 | Johnson |
| Beryllium Bronze | .56 | 4.8 | 33000 | Johnson |

* All values computed by using $K$-factor to take into account curvature and direct shear.
§ See footnote § on TABLE III.

TABLE V

**Endurance Limits and Physical Properties of Spring Materials in Bending**

(Round Specimens)

| Material | Dia. of Specimen or Wire inches | Heat Treatment* | Condition of Surface | Hardness | Ult. Strength (Tension) lb./sq. in. | Yield Point (Tension) lb./sq. in. | Elongation Per Cent | Endurance Limit in Reversed Bending lb./sq. in. | Investigator |
|---|---|---|---|---|---|---|---|---|---|
| .6% C. Steel | | O.Q. 950 C T. 500°C | Ground and Polished | 365 Br. | 177000 | 161000 | 7** | ±85000 | Hankins[1] |
| Cr. Va. Spring Steel | | O.Q. 850°C T. 600°C | Ground and Polished | 385 Br. | 177000 | 168000 | 7** | ±95000 | Hankins[1] |
| .65% C. Steel | .162 | | As recd. | | 221000 | | | ±76000 | Shelton, Swanger[2] |
| .65% C. Steel | .130 | | Ground and Polished | | 221000 | | | ±126000 | " " |
| .65% C. Steel | .148 | | As recd. | | 217000 | | | ±65000 | " " |
| Tempered Swedish Valve Spring Wire | .225 | | As recd. | 42 Rock. C | 204000 | 181000 | 10.5§ | ±67000 | Weibel[3] |
| Tempered Swedish Valve Spring Wire | .225 | | Rough ground 60 grit wheel 1 pass | 42 Rock. C | 204000 | 181000 | 10.5§ | ±81000 | " |
| Tempered Swedish Valve Spring Wire | .225 | | Shot blasted | 42 Rock. C | 204000 | 181000 | 10.5§ | ±85000 | " |
| High Carbon O.H. Steel .91% C .38% Mn | .273 | O.Q. 1575°F D. 940°F | Ground and Polished | 438-450 Br. | 225000 | 179000 | 7§ | ±80000 | Johnson[4] |
| Cr. Va. Steel .52% C.88% Cr .21% Va | | O.Q. 1600°F D. 810°F | Ground and Polished | 477-488 Br. | 237000 | 229000 | 11§ | ±104000 | " |
| High Carbon Electric Steel 1.04% C. .36% Mn. | | O.Q. 1550°F D. 800°F | Ground and Polished | 430-470 Br. | 237000 | 194000 | 5§ | ±98000 | " |

* O.Q. = oil quenched. T = tempered. D = drawn.

** In 8 inches.

§ In 2 inches.

1 Dept. of Sci. and Ind. Research, Eng. Res. Spec. Rep. No. 9.
2 Bureau of Stds. *J. of Research*, V. 14, 1935, RP 754, p. 17-32.
3 *Trans.* A.S.M.E., Nov. 1935, p. 501.
4 *Iron Age*, March 15, 1934, p. 12.

that the limiting stress ranges vary considerably in TABLE III, the limiting stress ranges for cold-wound carbon steel wire are 60,000, 52,000, 53,000, and 56,000 pounds per square inch. These variations are to be expected. The low values of 41,000 and 31,000 obtained by Lea and Dick on cold drawn wire may probably be explained by inferior quality of material and by the fact that tension springs were used in the tests. The large increase in endurance range due to shot-blasting is especially noteworthy. Similar data for the larger sized springs are given in TABLE IV.

On the basis of the data given in these tables the curves of *Fig.* 1 showing the values of endurance range which may be expected from good quality helical compression springs have been plotted. These curves may be expected to hold roughly for springs having indexes around 5 to 10. For larger indexes somewhat lower values may be expected, and vice versa for the smaller indexes. Since these curves represent rough averages considerable deviation may occur in individual instances. In particular it should be noted that the higher values of stress as obtained from shot-blasted springs cannot ordinarily be used in practice since considerable yielding or set may occur at such stresses. It would appear that shot-blasting increases the endurance limit so that yielding or set will occur before fracture. Because of stress concentration near the hook ends in tension springs, lower values of endurance ranges than those indicated in *Fig.* 1 may be expected.

From TABLE I it may also be noted that endurance limits in torsion as obtained on straight bars with ground and polished surfaces are in general considerably higher than those obtained on bars with surfaces untouched, or on helical springs of the same material, except those shot-blasted. By shot-blasting carbon steel springs it appears that the endurance limit

(*Continued on Page* 94)

TABLE VI

**Endurance Ranges and Physical Properties of Leaf and Flat Spring Materials in Bending**

| Material | Thickness of Specimen inches | Heat Treatment | Condition of Surface | Brinell Hardness | Ult. Strength (Tension) lb./sq. in. | End. Limit or Limiting Stress Range in Bending* lb./sq. in. | Investigator |
|---|---|---|---|---|---|---|---|
| .6% Commercial Carbon Spring Steel | 3/8 | Hardened and Tempered | As Recd. | 350-370 | | 0 to 42000 | Batson and Bradley[1] |
| .6% Commercial Carbon Spring Steel | 3/8 | Hardened and Tempered | .062 inch machined from surface after heat treatment | 350-370 | | 0 to 128000 | " |
| Silico-Manganese Steel | 3/8 | O.Q. 900°C T. 540°C | As Recd. | 390-400 | | 0 to 63000 | " |
| Silico-Manganese Steel | 3/8 | O.Q. 900°C T. 540°C | .062 inch machined from surface | 390-400 | | 0 to 110000 | " |
| .6% C. Spring Steel | 3/8 | Quenched and Tempered | As rolled | | | ±49000 | Hankins[2] |
| Swedish Spring Steel | .006 | | Polished | | 275000 | ±130000 | Hengstenberg[3] |
| Carbon Spring Steel 1%C | 1¼ | Quenched and Tempered | As rolled | Approx. 400 | | 0 to 86000 | Beeuwkes[3] |
| Carbon Spring Steel .5%C .56% Mn | | | As rolled | | 156000 | 34000 to 79000 51000 to 91000 | Lehr[4] |
| Chrome Va. Spring Steel | | | As rolled | | 164000 | 21000 to 92000 | " |
| Chrome Va. Spring Steel | | | Polished | | 171000 | —12000 to 126000 | " |
| Manganese Spring Steel | | | As rolled | | 188000 | 30000 to 84000 | " |

1 *Proc. Inst. Mech. Engrs.*, 1931, V. 120, p. 301.
2 Dept. of Sci. & Ind. Research, Special Rep. No. 5.
3 Tests made at Westinghouse Research Laboratories.
4 *Stahl und Eisen*, July 7, 1932, p. 653.
* Where two values are given for the same material, these correspond to actual ranges used in tests.

# Plastic PLANES!

**By John Delmonte**

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AIRPLANE fuselages and wing assemblies of laminated phenolic plastics are but one indication of the recently reawakened interest in the use of plywood construction, particularly in the field of transportation. This is due largely to developments in plastics adhesives, bonding, and impregnating agents which have given plywood new life by overcoming handicaps which limited the use of the materials in the past. Airplane manufacturers in particular are as well aware of the strength-weight advantages of wood construction as they are of the ravages of outdoor exposure which include fungi decay in the wood and loss of shear strength in the bonded joints due, among other things, to lack of waterproof qualities in the bonding agent. The advantages of the newer plastic materials in plywood construction lie not only in the improvement of the physical and chemical properties of the finished product, but also in the saving in time of manufacture and the floor space reequirements for conducting the bonding of the plywood.

Various techniques which have been developed for the bonding of plywood may be divided into several classifications:

1. Application of cold-setting adhesives
2. Hot bonding of plywood laminations at low pressures (up to 250 pounds per square inch)
3. Hot bonding of plywood laminations at high pressures (500-2000 pounds per square inch) with increased resin content.

COLD-SETTING ADHESIVES: In applying cold-setting adhesives to plywood construction it has been desirable to use a number of water-soluble materials which set hard upon drying. Various glues such as casein, animal, starch, albumen, soya-bean, etc., have been employed. The usual procedure is to apply the adhesive as uniformly as possible, and under a clamping pressure bring the surfaces together in intimate contact. The pressure of the clamps is maintained until the adhesive has set hard, which may be a matter of hours. For many articles employing wood veneers subject to inside exposure only, this technique is still widely practiced.

### Resin Hardened by Catalyst

One of the more recent developments in cold-setting adhesives is the application of a urea-formaldehyde synthetic resin which may be hardened in a relatively short time by the application of the proper catalyst. This is accomplished without an increase in temperature though this same synthetic resin may be hardened by heat without catalyst. In its pure form, stronger joints are formed which are more resistant to water than the other adhesives mentioned in the preceding paragraph. However, it is usually

extended with wheat or rye flour to lower the cost per pound. While the strength and water resistance remains superior to other types for a considerable amount of dilution with an extender, increasing proportions will lower the strength and the cost. Depending upon the nature of the veneers being bonded and for what purpose they are intended, it is possible to adjust a suitable ratio and attain a certain strength at a specified cost. Manufacturers of this material (Uformite) indicate that as high a ratio as two parts of flour to one of resin is suitable for low cost adhesives used in veneers such as those found on mirror backs or dust panels, where little bonding strength is necessary.

HOT BONDING AT LOW PRESSURES: Application of thermosetting adhesives to plywood construction inaugurated the development of hot-bonding techniques. Thermosetting plastic materials such as phenol-formaldehyde and urea formaldehyde attain their best physical properties when cured under heat and pressure, polymerizing to a hard, infusible structure which is water resistant and very strong. Dr. Baekeland, originator of the phenolic resins which bear his name, recognized the possibilities of phenolic resins in plywood construction. As early as 1912 a patent was issued to him covering such an application (U. S. 1,019,408). However, the technique of using an alcoholic solvent increased the cost considerably, and the procedure did not find wide commercial acceptance. Developments ensued in the following years such as applying the synthetic resin in emulsion form and spraying it between the plywood laminations. Nevertheless, best results have been obtained with the more recent technique of applying the phenolic resin in a thin film form. As early as 1919, this technique was suggested for impregnating thin tissue paper with phenolic resin. Dry application of the film affords the big advantage that uniform distribution of the plastic material is instantly obtained.

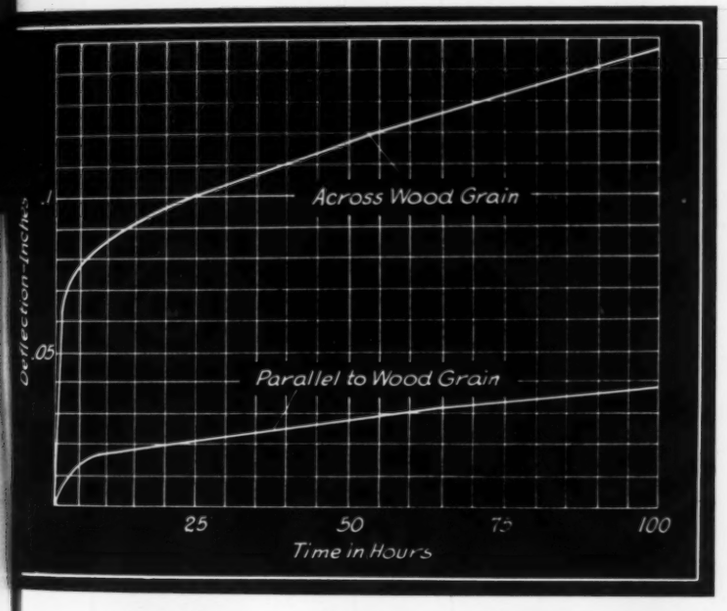



**Fig. 1—Creep and cold flow data obtained at 1000 pounds per square inch tension at 85 degrees Fahr. on high pressure plastic laminated plywood**

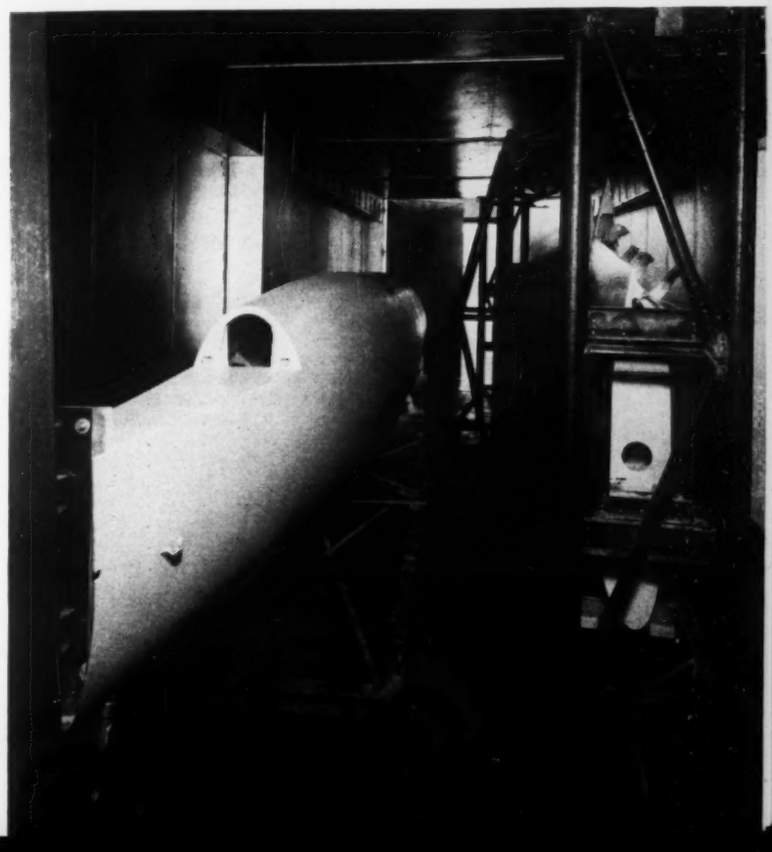
Veneer manufacturers have, of course, to invest in presses with hot steam platens to effect the cure of the resin bonded veneers, which are stacked alternately with the resin films. In the case of aircraft manufacturers special techniques have been developed in which the veneers are assembled over low-cost dies and forms, with the thermosetting resin sprayed on or applied in film form between each wood veneer (usually spruce). The composite assembly is cured under heat in a tank where pressures between 50-150 pounds per square inch may be obtained. Pressures up to 250 pounds per square inch are recommended for bonding veneers with phenolic resin films. Pressures and temperatures that are employed are dependent not only on the type of wood, but also the moisture content of the wood. A typical airplane (Timm Aircraft Company) and a wing and fuselage assembly, which are developed from spruce veneers and thermosetting phenolic plastic adhesives are shown in the head illustration and *Fig.* 2.

## Density of Wood Unchanged

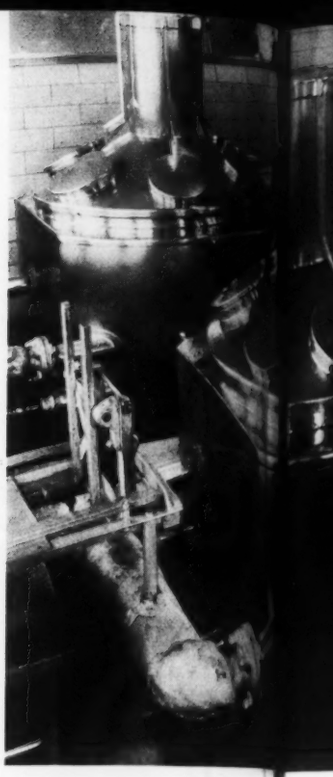
In these and other "plastic" airplane constructions, the density of the wood (which is about half that of the resin) is not altered appreciably inasmuch as little of the plastic material is used and this does not penetrate deeply at the pressures employed. However, there is little doubt of the superiority of the plywood bonded with these materials over the naturally occurring adhesives with respect to water resistance (they will withstand boiling water) and shear strength. Mold and fungus growth which limited the

(*Continued on Page* 89)

**Fig. 2—Smooth, low drag surface obtainable with laminated plastic is evidenced by this molded plywood fuselage**



# How About Stainless for That Tough Spot?



**By H. A. Grove**

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*Massillon, Ohio*

STAINLESS steel is being utilized increasingly in mechanical design because it combines corrosion resistance with desirable mechanical properties. Of the two general types of stainless steel the straight chrome grades are used where parts must be hardened for wear and where corrosion is mild or heat resistance required; the chrome-nickel grades cannot be hardened by heat treatment but their physical properties can be increased by cold working. The latter are used where corrosion problems are extremely severe.

Chemical composition of the stainless grades more commonly used in mechanical design are shown in TABLE I, according to American Iron & Steel Institute type numbers. Of these grades, the free-machining types are somewhat less resistant to corrosion than their sister types but are used where a small amount of corrosion resistance can be sacrificed for increased machinability. The other grades can be machined, though not as readily as types 416, 430-FM and 303; they are especially good however, where forming, forging and corrosion resistance are all-important.

As far as mechanical properties are concerned, TABLE II will show what can be expected from some of the grades. All have not been included but their average properties can be judged by comparing their composition with those given.

In selecting a suitable type of stainless steel for a mechanical part, great care must be exercised before setting up specifications, as the composition is a vital point in obtaining satisfactory results. One should also bear in mind that in forming or drawing stainless steel, more strength will be required in the presses than in forming low carbon sheet steel. This can be appreciated from TABLE II, from which it will be noted that average strength of stainless in the annealed or soft condition is about one and one-third times that of ordinary steel.

In TABLE III are other properties of stainless which are important in mechanical design. In applications where temperatures are involved, the designer has several things to consider such as coefficient of thermal expansion, scale resistance, strength at elevated temperatures, etc. For temperatures up to approximately 1500 degrees Fahr., where there is little or no corrosion, the straight chrome grades; namely 410, 416 and 430, are generally used. Where temperatures are much higher, types 309 or 446 are usually employed, depending on the part and application. Chrome-nickel grades should be avoided

Fig. 1 — Below —Fabricated by seam, projection and spot welding, this refrigerator evaporator is type 304

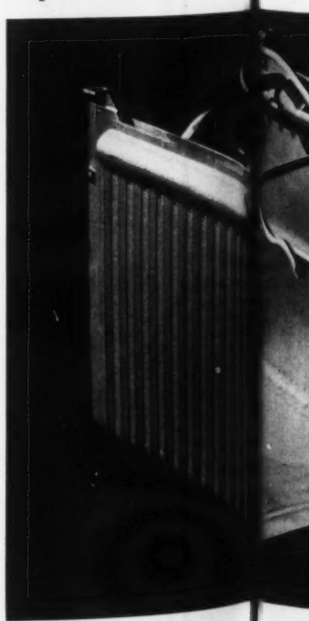


TABLE I

**Composition of Commonly Used Stainless Steels**

| Steel Type No. | Composition | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | C. | Mn. | P. | S. | Si. | Cr. | Ni. | Other elements |
| 410 | .15 max. | .60 max. | .03 max. | .03 max. | .60 max. | 10. –14. | ..... | ..... |
| 414 | .15 max. | .60 max. | .03 max. | .03 max. | .60 max. | 10. –14. | 1.– 2. | ..... |
| 416† | .15 max. | .60 max. | .03 max. | .20–.40 | .60 max. | 12. –14. | ..... | Mo .40–.60 |
| 420* | .15 min. | .50 max. | .03 max. | .03 max. | .50 max. | 12. –14. | ..... | ..... |
| 430 | .12 max. | .50 max. | .03 max. | .03 max. | .50 max. | 14. –18. | ..... | ..... |
| 430-FM† | .12 max. | .50 max. | .03 max. | .20–.40 | .50 max. | 14. –18. | ..... | Mo .40–.60 |
| 431 | .15 | .50 max. | .03 max. | .03 max. | .50 max. | 14. –18. | 1.– 2. | ..... |
| 440* | .15 min. | .50 max. | .03 max. | .03 max. | .50 max. | 14. –18. | ..... | ..... |
| 446 | .35 max. | .50 max. | .03 max. | .03 max. | .50 max. | 23. –30. | ..... | ..... |
| 301-X | .20 max. | 1.25 max. | .03 max. | .03 max. | .70 max. | 16. –18. | 7.– 9. | ..... |
| 302 | .20 max. | 1.25 max. | .03 max. | .03 max. | .75 max. | 17.5–20. | 8.–10. | ..... |
| 303† | .20 max. | 1.25 max. | .16 max. | .03 max | .75 max. | 17.5–20. | 8.–10. | Se .07 min. |
| 304§ | .08 max. | 2.00 max. | .03 max. | .03 max. | .75 max. | 18.0–20. | 8.–10. | ..... |
| 316 | .08 max. | 2.00 max. | .03 max. | .03 max. | .75 max. | 16.–018. | 10.–14. | Mo 2.–3. |
| 309 | .20 max. | 1.50 max. | .03 max. | .03 max. | 2.00 max. | 22.0–26. | 12.–14. | ..... |

†These grades are the free machining types. *High carbon may be specified for increased hardenability.. §Titanium (type 321) or columbium (type 347) may be added for carbon stabilization. Used for parts operating between 1000 and 1700° F., where corrosion is also a problem.

**Fig. 2—Mixers for ice cream indicate an outstanding application of stainless in design of sanitary equipment**

for high temperature work in connection with sulphurous bearing fuels, such as oils. When applications of 1000-1700 degrees Fahr. also include fairly severe corrosive problems, types 347 and 321 (18-8 plus columbium or titanium) are used. In these grades the carbon is stabilized or repressed at the high temperatures, thereby minimizing the tendency to corrosion by carbide precipitation. High temperature design generally includes such applications as conveyor rolls or belts, screw conveyors, chains, sprockets, fans, valves, oil burner nozzles, jets, injectors and other machine parts for similar applications.

As a rule all stainless grades can be welded if the proper technique is employed but the chrome-nickel grades generally weld better than the straight chrome grades. The difficulty encountered with the latter is their tendency to become brittle, this being due to their characteristic of hardening when heated. This brittleness can be overcome in several ways. One is to anneal after welding and another is to add certain alloys and keep the carbon content low, so that these types will have less tendency to harden from the welding temperatures.

## Corrosion Problems Require Study

While it would be impossible to give here the corrosion resistance of stainless steels in a large number of solutions, TABLE IV shows the relative resistance of the three most common grades in several different acid and salt solutions.

The selection of stainless for a corrosion problem should always be given study on the part of the designer. What solutions or substances will come in contact with the metal, will they be moving or not, will the machine or part be cleaned and how often? These are all-important factors in combatting corrosion. Moist solids, especially if stationary, are apt to cause contact corrosion. Also, any machine or piece of equipment subject to a corrosive medium should be so designed that it can be cleaned thoroughly at regular intervals.

Fields in which corrosion is a vital factor include the textile industry, where type 302 or 304 is employed for cotton dyeing and type 316 for wool dyeing; the photographic industry where type 316 is employed for developing solutions and type 304 for fixing baths; the dairy, food and beverage industries where type 304 is utilized almost exclusively; the paper and pulp industry in which type 316 is used extensively because of the high sulphate content of the solutions usually employed.

To combat atmospheric and like corrosion, stainless is used for moving parts such as cams, gears, sprockets, shafts, chains, guides, diaphragms, etc. Types 410, 416, 414 and other heat treatable grades are employed

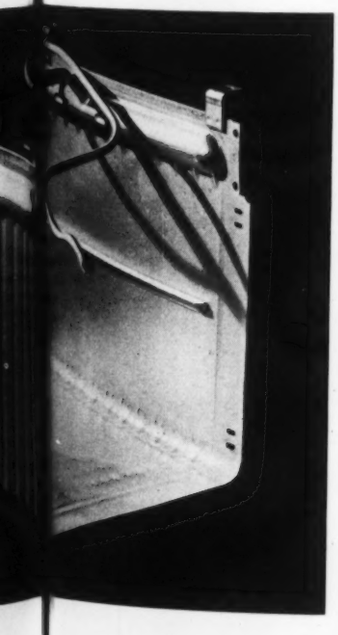


TABLE II

**Tensile Properties of Stainless Steel**

| Type of Material | Heat Treatment | Rockwell Hardness | Approx. Yield Strength 1000 p.s.i. | Approx. Tensile Strength 1000 p.s.i. | Elong. in 2" per cent |
|---|---|---|---|---|---|
| 410 | Annealed | 75- 85 B | 35- 45 | 65- 85 | 35-25 |
| | Heat Treated* | 30- 40 C | 60-180 | 100-200 | 25-10 |
| 416 | Annealed | 75- 90 B | 40- 50 | 70- 85 | 35-25 |
| | Heat Treated* | 10- 30 C | 60-130 | 80-160 | 25-15 |
| 414 | Annealed | 95-105 B | 100-115 | 115-130 | 20-15 |
| | Heat Treated* | 30- 50 C | 105-205 | 120-250 | 15- 5 |
| 420 (.25-.35 C) | Annealed | 90-105 B | 60- 80 | 90-110 | 25-15 |
| | Heat Treated* | 25- 52 C | 120-210 | 120-250 | 15- 3 |
| 430 & 430-FM | Annealed | 75- 90 B | 40- 55 | 70- 90 | 30-20 |
| 440 (.65-.75 C) | Annealed | 90-100 B | 50- 65 | 90-110 | 25-15 |
| | Heat Treated* | 25- 55 C | 100-240 | 130-270 | 15- 2 |
| 446 | Annealed | 80- 90 B | 45- 60 | 75- 95 | 30-20 |
| 301 | Annealed | 82- 87 B | 35- 50 | 75- 90 | 55-60 |
| | ¼ Hard‡ | 34- 30 C | 85-105 | 125-145 | 40-35 |
| | ½ Hard | 38- 34 C | 130-150 | 150-170 | 30-22 |
| | ¾ Hard | 42- 37 C | 155-180 | 175-195 | 25-15 |
| | Full Hard | 45- 40 C | 170-190 | 185-205 | 15- 5 |
| 304 | Annealed | 75- 83 B | 30- 45 | 70- 90 | 55-65 |
| | ¼ Hard | 32- 28 C | 100-115 | 125-135 | 30-20 |
| | ½ Hard | 35- 32 C | 135-150 | 150-165 | 20-15 |
| | ¾ Hard | 38- 35 C | 160-180 | 175-190 | 15-10 |
| | Full Hard | 40- 38 C | 165-185 | 175-190 | 10- 2 |

*These figures cover properties obtainable in the quenched and drawn state. Quenching temperature 1750-1850 degrees Fahr. Draws from 1250 degrees Fahr. to 400 degrees Fahr.
‡Cold rolled tempers.

TABLE III

**Thermal, Electrical, Fabricating Properties of Stainless Steel**

| Property | Type of Material 410 | 416 | 430 | 446 | 302 | 303 | 316 | 309 |
|---|---|---|---|---|---|---|---|---|
| Coeff. of Expansion per °F. x $10^{-6}$ | | | | | | | | |
| 0- 200° F. | 5.7 | 5.7 | 5.4 | 5.3 | 9.0 | 9.0 | 8.4 | 8.0 |
| 0- 600° F. | 6.1 | 6.1 | 5.6 | 5.5 | 9.5 | 9.5 | 9.0 | 8.6 |
| 0-1000° F. | 6.7 | 6.7 | 6.1 | 6.0 | 10.1 | 10.1 | 9.7 | 9.5 |
| 0-1500° F. | 7.0 | 7.0 | 6.3 | 6.2 | 11.1 | 11.1 | 11.0 | 10.8 |
| Creep Stg. for 10,000 hrs.—1% El. | | | | | | | | |
| At 1000° F. p.s.i. | 13,000 | 13,000 | 8,500 | ..... | 17,000 | ..... | 25,000 | 17,000 |
| At 1100° F. p.s.i. | 5,000 | 5,000 | 5,000 | .. .. | 12,000 | ..... | 20,000 | 13,000 |
| At 1300° F. p.s.i. | 1,500 | 1,500 | 1,400 | 800 | 4,000 | ..... | 10,000 | 4,800 |
| At 1500° F. p.s.i. | ..... | ..... | ..... | ..... | 850 | ..... | 3,000 | 850 |
| Heat Resistance Scaling Temp. deg. F. | | | | | | | | |
| Continuous Service | 1250 | 1250 | 1500 | 1900 | 1600 | 1600 | 1650 | 2000 |
| Intermittent Service | 1400 | 1400 | 1600 | 2000 | 1450 | 1450 | 1500 | 1800 |
| Elec. Resistivity Microhms/in³, 70° F. | 22.5 | 22.7 | 23.5 | 26.5 | 27.6 | 27.6 | 28.5 | 30.0 |
| Magnetic Prop. Annealed State | Mag-netic | Mag-netic | Mag-netic | Mag-netic | Non-Mag-netic | Non-Mag-netic | Non-Mag-netic | Non-Mag-netic |
| Welding Properties | Fair—Welds Brittle | Poor—Welds Brittle | Fair—Welds Brittle | Fair—Welds Brittle | Very Good Tough Welds | Fairly Good May Crack | Very Good | Very Good |
| Machining Properties | Fair | Good | Fair | Fair | Fair Tough | Good | Fair | Fair |
| % compared with screw stock | 60 | 80 | 60 | 50 | 40 | 70 | 40 | 23 |
| Drawing and Stamping | Fair | Poor | Good | Poor | Very Good | Fairly Good | Good | Good |

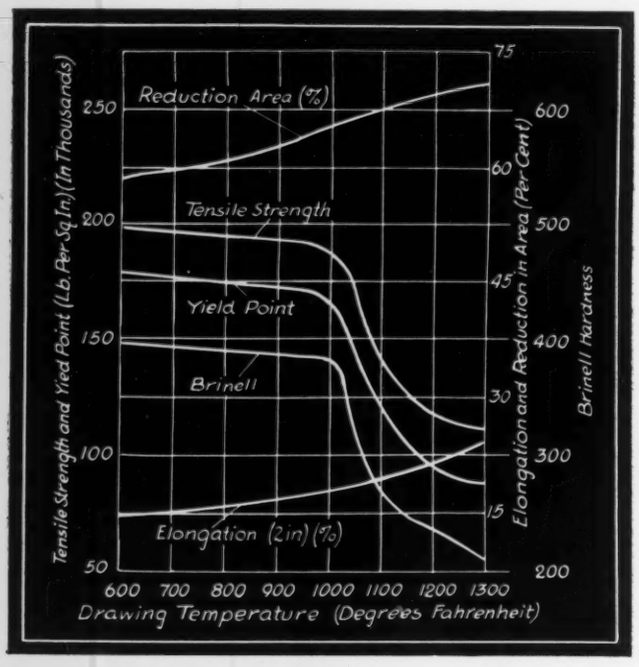



**Fig 3—Physical properties of type 410 stainless steel plotted against draw temperatures. Material was heat treade din 1-inch rounds, tested in 2X .505-inch specimens**

where working parts require primarily a hard wearing surface but must also have some corrosion resistance. If corrosion resistance becomes the prime factor and the working part must also be hard, then type 301-X cold worked to the desired hardness is generally utilized. Vital moving parts in coin and amusement machines are often stainless to keep them working without extensive maintenance when placed in outside locations.

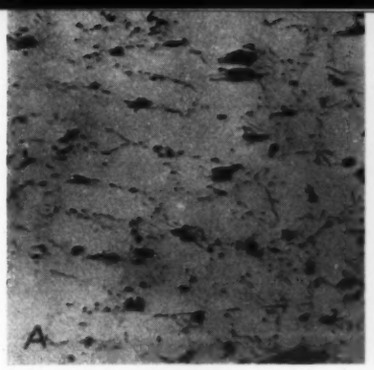
Initial cost of stainless may sometimes look prohibitive when compared with carbon or low alloy steel but the saving it may offer in eliminating replacements and possible costly failures will greatly offset this original expense. Further, it may often prove more economical because its higher mechanical properties will allow a lighter design in section.

TABLE IV

**Corrosion Resistance of Stainless Steel**

| Solution | Strength percent | Temperature degrees Fahr. | Corrosion Resistance* by Type 316 | 302 | 430 |
|---|---|---|---|---|---|
| Acetic | | | | | |
| Acid | 5 | 70 | A | A | A |
| Acid | 5 | 180 | A | A | D |
| Acid | 10 | 70 | A | A | A |
| Acid | 10 | 180 | A | A | . |
| Acid | 20 | 70 | A | A | A |
| Acid | 20 | 180 | A | A | .. |
| Acid | 50 | 70 | A | B | .. |
| Acid | 90 | 180 | A | C | .. |
| Nitric | | | | | |
| Acid | 5 | 70 | A | A | A |
| Acid | 5 | Boiling | A | A | C |
| Acid | 20 | 70 | A | A | A |
| Acid | 20 | Boiling | A | A | B |
| Acid | 50 | 70 | A | A | A |
| Acid | 50 | Boiling | A | A | B |
| Acid | Conc. | 70 | A | A | A |
| Acid | Conc. | Boiling | B | B | C |
| Sulphuric | | | | | |
| Acid | 5 | 70 | B | C | C |
| Acid | 5 | Boiling | C | E | E |
| Acid | 10 | 70 | B | C | C |
| Acid | 10 | Boiling | D | E | E |
| Acid | 50 | 70 | C | E | E |
| Acid | 50 | Boiling | D | E | E |
| Acid | Conc. | 70 | A | A | A |
| Hydrochloric Acid | Not recommended | | | | |
| Nitrates | .. | .. | A | A | B |
| Sulphates | .. | .. | A & B | B-C | C-D-E |
| Phosphates | .. | .. | A-B | A-B | B-C |
| Chlorides | | | | | |
| Strong | Not generally recommended. | | | | |
| Weak (some) | .. | .. | C | .. | .. |
| Food Stuffs | .. | .. | A | A | .. |
| Beverages | .. | .. | A | A | .. |
| Dairy Products | .. | .. | A | A | .. |
| Oils | .. | .. | A | A | A |
| Molten Metals | .. | .. | E | E | E |

*Key to corrosion resistance columns: A—Fully Resistant; B—Satisfactorily Resistant; C—Fairly Resistant; D—Slightly Resistant; E—Not Resistant.



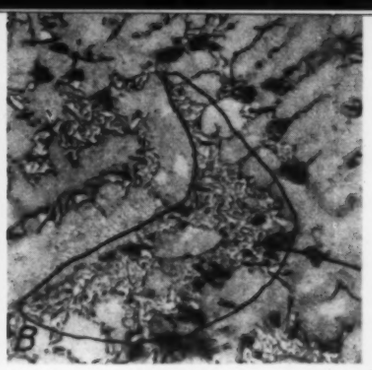
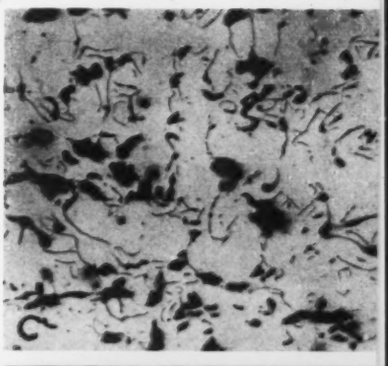
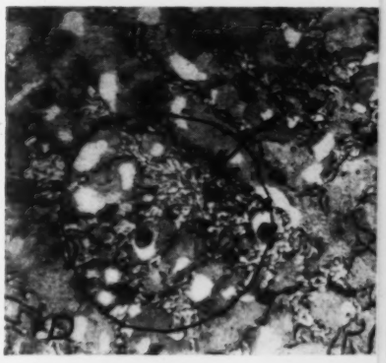


Fig. 1—Photomicrographs of bed and saddle of lathe, etched and unetched. Scoring was caused by primary ferrite, shown circled





# How Casting Procedure Eliminates Scoring

By F. J. Dost

*Sterling Foundry Co.*

DESPITE the rapid progress of cast iron metallurgy in recent years, comparatively little work has been done on the problem of wear resistance since the inception of high-strength iron. Until about ten years ago the conventional "semisteel" mixtures which included 25 to 50 per cent steel of the high-carbon, low-silicon type, were used for many wearing parts but were not altogether satisfactory. High-strength iron was developed to meet the deficiencies and consisted of mixtures having 70 to 95 per cent steel with low carbon and high silicon. TABLE I compares the two irons for the same size casting.

Except for an occasional case of scoring or galling of wearing surfaces such as in machine tools, high-strength iron appeared to be ideal from every standpoint. While the frequency of scoring was very low it presented a new problem, and a comprehensive study was made to improve quality of the castings.

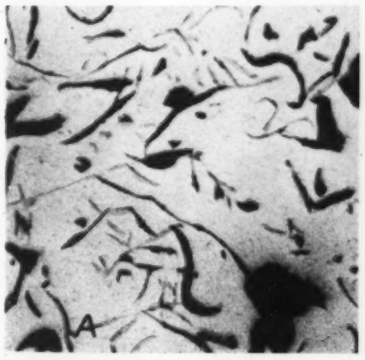
The procedure followed was to take microscopic specimens from the wearing surfaces of both the bed and the immediate sliding member of the machine in question, and to examine the structure at the actual wearing surface. A chemical analysis was also made to correlate composition with this structure. First findings are in Fig. 1.

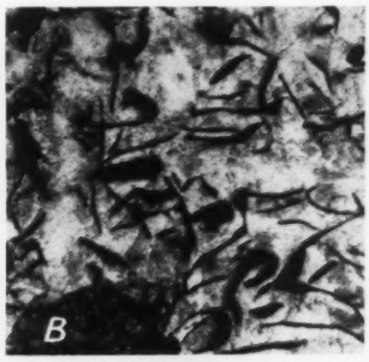
It will be noted that *A* shows a dendritic pattern and that, instead of having a flake-graphite, it has a nodular formation. Unfortunately, *B* is magnified only 100 times and does not resolve the matrix in complete

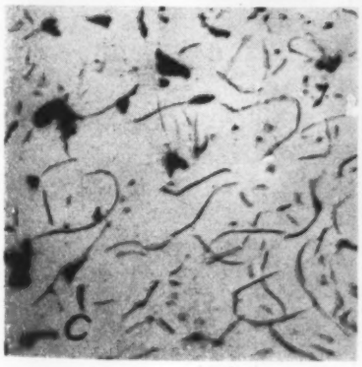
TABLE I

**Chemical Compositions of Old and New Type Irons**

| | 20-50% Steel | 70-95% Steel |
|---|---|---|
| Carbon | 3.25-3.50 | 2.70-3.00 |
| Silicon | 1.10-1.25 | 1.85-2.25 |
| Manganese | 0.60-0.70 | 0.70-0.90 |
| Phosphorus | 0.10-0.30 | 0.20 max. |
| Sulphur | 0.08-0.12 | 0.10 max. |
| Nickel | 1.00 | 1.00-2.00 |
| Brinell | 163-187 | 207-269 |







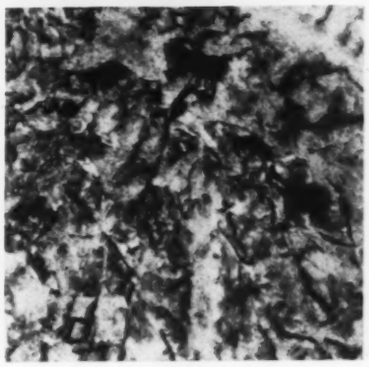


Fig. 2—This iron was cast in same lot of same mixture as in Fig. 1 but does not show any primary ferrite. Taken from machine in service. Subsequent heat treatment caused difference

Presented at semiannual meeting, ASME.

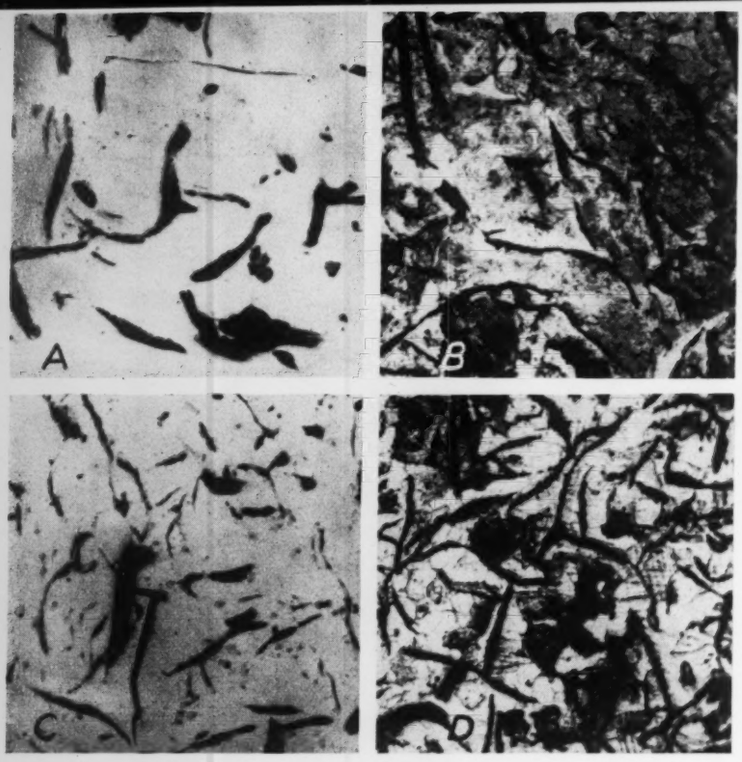



Fig. 3—Photomicrographs of iron from machines in service over fifteen years. Secondary ferrite is present but no scoring occurred. This iron is porous and soft

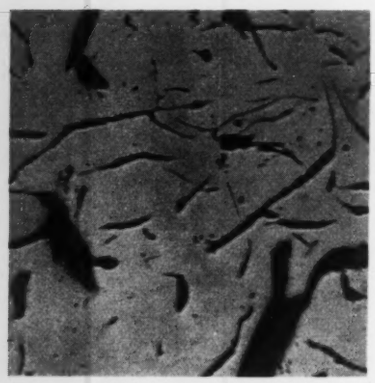


Fig. 4—Left—Additions of amorphous graphite to high-strength iron brought a medium graphite flake evenly distributed

detail. Examination at 500 times shows the light gray areas as very fine pearlite. The constituent circled will be discussed subsequently. Mostly nodular graphite is shown in *C*, although there is some flake present. A slight dendritic pattern is noticeable. In *D* the same specimen is shown etched, and magnified 100 times.

Subsequent cases of scoring or galling were treated in the same manner. All the findings indicated that either the bed or saddle, or both, had a dendritic pattern. We also found that accompanying this dendritism was a peculiar type of constituent to which reference will be made later.

Our next step was to investigate the reason why machines cast in the same lot of the same mixture were giving satisfactory results. *Fig.* 2 shows photomicrographs made from specimens taken from the machine in service. In *Fig.* 2, *A* clearly shows a flake-graphite formation well distributed; *B* is the same specimen etched and shows a fully pearlitic structure. When examined at 500 magnification this is shown more clearly. In *C* both nodular and flake formation are apparent, the flake being considerably finer than in *A; D* shows the same iron etched, bringing out a slight dendritic formation with a pearlitic-sorbitic matrix but none of the peculiar constituent indicated in *B* and *C*.

It was then decided to investigate machines which had been in service for 15 or 20 years and had worn gracefully without scoring, and generally had given satisfactory service. The same procedure was followed as in the previous cases. *Fig.* 3 illustrates a representative set of conditions for this class of iron, which gave a porous finish as well as a low hardness.

In *Fig.* 3, *A* shows a large graphite-flake formation, while *B,* the same iron etched, shows a ferritic-pearlitic matrix. A coarse graphite formation is shown in *C*. In the etched condition it is very evident that the matrix is nearly 100 per cent ferritic. A new constituent has entered the picture, namely, secondary ferrite. But regardless of this, the machine did not score or gall even though it suffered considerable wear.

It should be emphasized that the foregoing illustrations are not of one machine but are representative of the entire investigation.

Since the peculiar structure seen in *Fig.* 1, *B* and *D*, was found only in cases of scoring or galling, while none of the machines giving satisfactory performance showed this constituent, it was logical to assume that we had a clue to its cause. This type of structure has been variously referred to as "primary ferrite," "eutectic," "pseudo-eutectic," "supercooled," "snowball," etc. The nature of the constituent is a fine ground mass of ferrite and graphite, which is soft or mushy, comparatively speaking, and easily dislodged from the parent metal by sliding friction under heavy loads.

(*Continued on Page* 96)

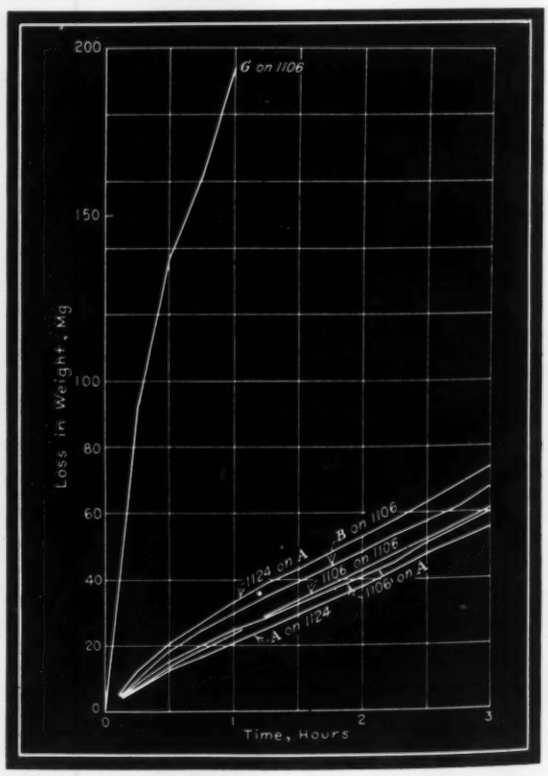



Fig. 5—Nearly vertical curve shows excessive wear or scoring on iron with large amounts of primary ferrite. Other curves represent irons free from primary ferrite. Secondary ferrite may be present

MACHINE DESIGN

# Editorial

## War's Effect on Materials

ALREADY the war in Europe is giving cause for serious misgivings on the part of materials suppliers. Coupled with the need for war equipment abroad, our defense program is unquestionably destined to play a major role in restricting the supply of materials for more conventional design purposes. That is just as it should be, and there can be no kicks coming if national emergencies impose hardships on both suppliers and users.

That such will be the case to an increasing extent is borne out not only by the current heavy demand but by the size of the appropriation authorized by the government for building up supplies during the next four years. Markets will be highly competitive, substitutions will be needed and deep thinking will be called for on the part of designers to cope with the unprecedented conditions that will prevail.

Progressive manufacturing companies even now are taking steps to offset future limitations and bottle necks. MACHINE DESIGN will in future issues present articles bearing on specific instances of changes in design or having to do with substitutions and other factors in development made mandatory by the restrictions.

It is planned that articles of this type will supplement the eighth edition of MACHINE DESIGN'S Directory of Materials, stitched into the center of the current issue, the compilation of which has been given special consideration in view of present events and future possibilities.

## Award!

READERS will vividly recall the series of articles, "Photoelastic Analysis in Commercial Practice," by R. E. Orton, published in the March to July issues. In arranging for the presentation of this series, no doubt was felt as to the extent of its appeal to chief engineers and designers who are ever on the alert for new ideas and developments. Actual reception of the articles, as well as a flood of letters requesting reprints, bears ample testimony to the keenness of MACHINE DESIGN'S readers in welcoming technical articles of this caliber.

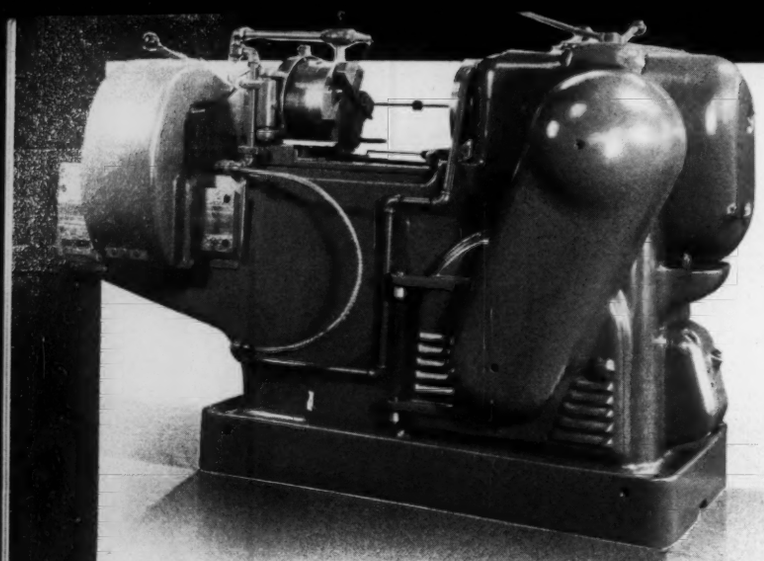
Further approval was quickly forthcoming! The five articles gained for MACHINE DESIGN the honor of first award for "editorial achievement in presenting the best series of articles or editorials published during the twelve months ending July 31, 1940." The award was sponsored by *Industrial Marketing,* based on the judgment of a jury of awards which included leading engineers, journalists and advertising executives.

The editors of MACHINE DESIGN are proud of this recognition and, if any assurance should be necessary, pledge themselves to maintain their efforts in seeking and publishing articles of equally outstanding merit.

# *Design Features* IN NEW MACHINES

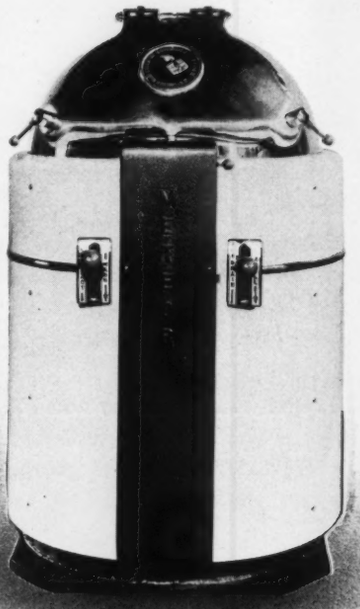
With Special Reference to Choice of Materials

(For new machine listing see pages 110 and 112)



Cast base of Landmaco threading machine (above) includes integral headstock. Face plate on spindle supplants usual diehead and incorporates a live center. A special carriage front mounts the stationary diehead. The tailstock is adjustable and supports a center which is advanced to or withdrawn from the work by a quick-acting lever located on top of the tailstock. Controls are conveniently simplified and centralized

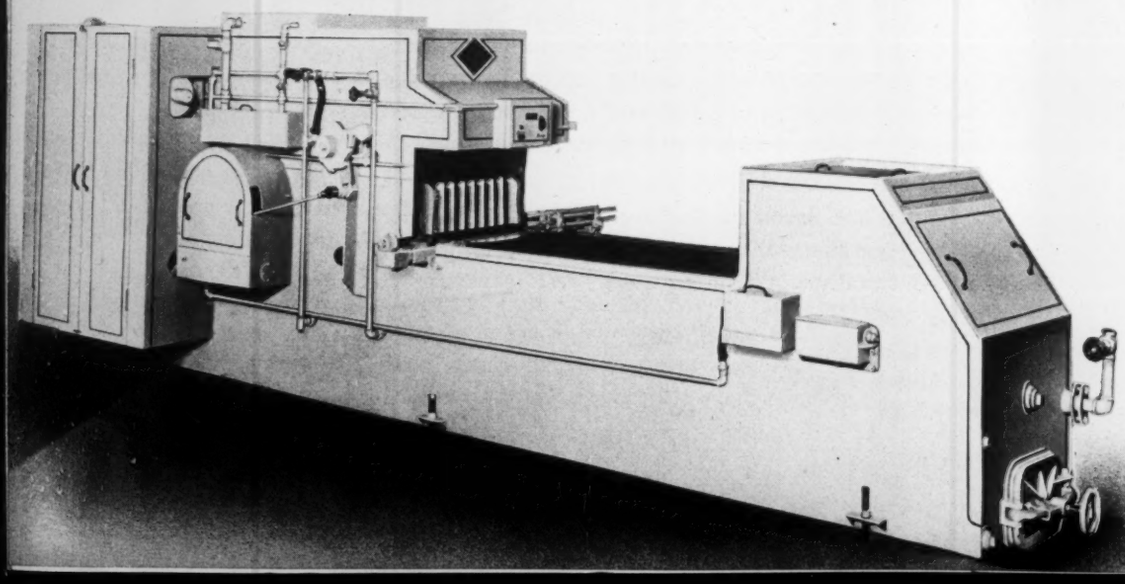
THIS MONTH'S COVER. Hopper of Will-Burt stoke is heavy copper-bearing steel while hopper base is hea ribbed cast iron. Front cover is sheet steel and coal fee screw cast steel. An automatic air control increases or d creases the air supply admitted to the fuel bed, its operatio being governed by resistance in the fuel bed and by the veloci of air flow through the tube connecting fan and windbo



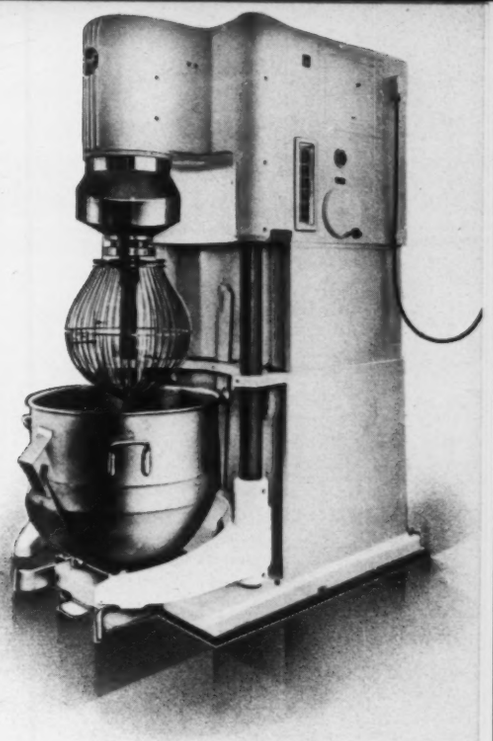
Half spheres of the Meteor washer-extractor (right) are drawn in one piece from heavy Monel metal and the frame is a heavy steel cylinder, electrically welded. Specially designed solvent seals around the shaft prevent leakage. Drive is a two-speed gearmotor incorporating a multiple disk clutch. Adjustable link type V-belts are used

Chart housing and upper portion of the base of the Toledo butter print scale (right) are one-piece aluminum casting without surface crevices. All major working parts are stainless steel and other parts are specially plated to guard against corrosion. Self-adjusting shock absorber brings indicator to rest quickly. Finish is gray enamel

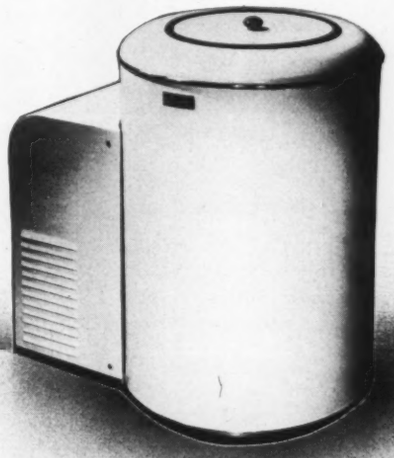
Sheet steel with white baked enamel finish comprises housing of Red Diamond universal bottle washer (below). Each element of endless conveyor is a cast bar containing openings to receive necks of bottles. Spring-actuated clamps retain bottles in place. Stainless steel is prominently used for parts in contact with liquids



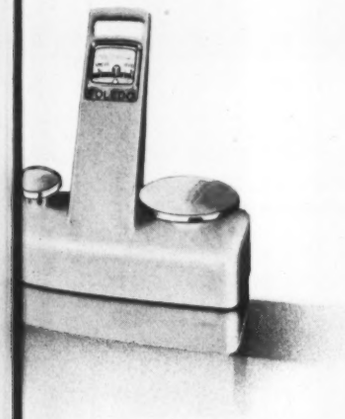
An example of the defense equipment being built by private industry is the light 12-ton Army tank (above). Vulnerable points are covered with heavy armor plate steel. Carrying four men, the tank has a top speed of 30 miles per hour. The armament—37-millimeter cannon and machine guns—typifies the trend toward using guns capable of piercing opposing machines of the same size

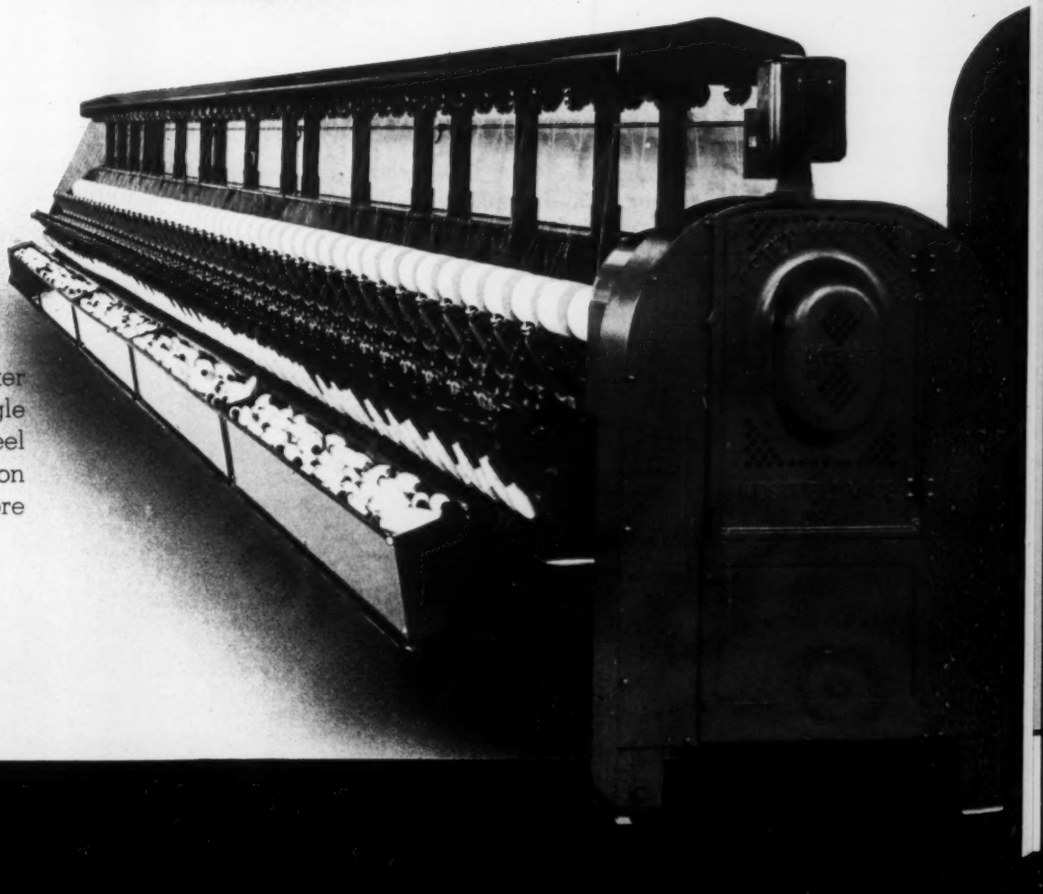


Base and rear part of head of AMF Glen dough mixer (above) are welded steel, forward part of head is cast iron. Beater drive goes from motor through silent chain to variable speed transmission, while another motor lowers saddle and raises head. Controls are grouped at upper right and include only handwheel, tachometer and panel pushbutton. Mercury limit switches and mechanical stops assure safety



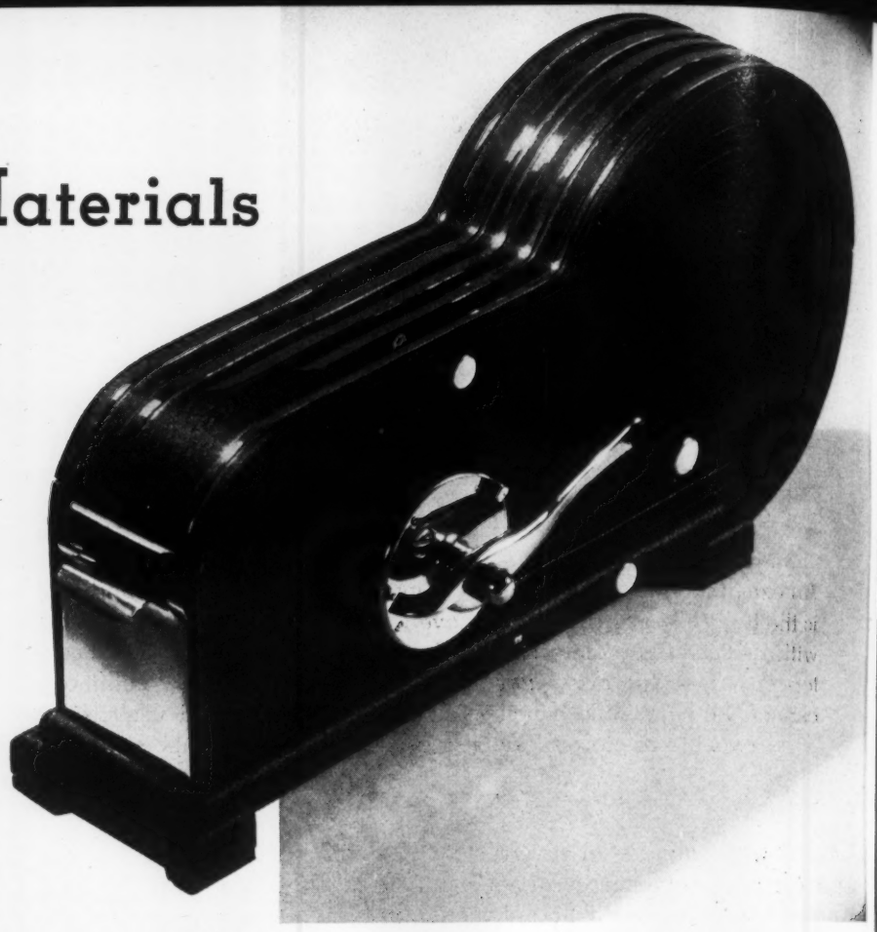
A double-wall cylinder of heavy steel with the capacity of a barrel serves both as a food box and as a cooling element in the Deep-Freeze food locker (right). Freon circulates between the walls. The compartment adjoining the main cylinder houses a standard capacitor type motor and a two-cylinder compressor. Four-inch wall of insulation surrounds cold cylinder





ast iron and steel predominate in the Foster rn doubler (right). Drive is by V-belt, a single iveshaft operating three other shafts. Steel d fiber gears mesh together. Anti-vibration nsions give equal tensioning on the two or more ends of yarn winding on each spindle

# Change in Materials Facilitates Redesign



BY TAKING full advantage of materials and the processes by which parts are to be made, designers are often able to effect reductions in cost and improvements in utility and appearance of machines. An interesting case in point is offered by comparison of the Supermatic sealer in *Fig.* 1 and the machine it superseded, the sealer in *Fig.* 2.

Fig. 1—New sealer in which housing, cover and twelve other parts are die cast

Gummed paper tape is dispensed by the machine from a roll in a compartment occupying about half of the space within the machine. A pair of rolls feeds the tape by friction when an operating lever is turned about its pivot, and a knife shears off the tape when the lever is released and returned by a spring.

In the earlier machine 21 parts were produced in the screw machine, four were iron sand castings, 20 were stamped, and others included four gears and a gear segment. Not all of these parts were well adapted to their functions and others had to be made from relatively expensive materials.

In developing the newer model, a design was worked out which takes full advantage of the inherent benefits of zinc alloy die castings, not only for the housing but for the cover, operating lever and several interior parts. Although this involved a considerable investment in casting dies, total tool cost was not much greater than for the original machine and the net saving in each of the newer machines soon offset the tool investment.

Primary economy came from redesigning the housing which also serves as the frame of the machine. In the earlier model, *Fig.* 2, the housing consisted of a cast iron base with a stamped enclosure fastened to it by screws. Major parts forming the side walls of the enclosure were a pair of 1/16-inch plates bent at right angles at each end to form also the end walls. Joints at each end resulted and were covered by a pair of narrow inside plates riveted and screwed to the formed plates, having inward flanges fastened by screws to the base.

Fig. 2—Below—Parts in older model were not expensive in themselves, but required several costly assembly operations

While these parts were not expensive in themselves they required several assembly operations. Although the main plates were quite heavy, they did not provide satisfactory bearing bosses for the cross shafts. A separate boss was needed for the pivot screw of the operating lever, and it also was necessary to rivet in place some small stamped parts for bearings above the level of the top of the main plates. The net re-

sult was an expensive and awkward, unpleasing housing. Some projections were hidden by a heavy sand-cast iron cover hinged to the frame at the rear, but they were exposed when the cover was raised.

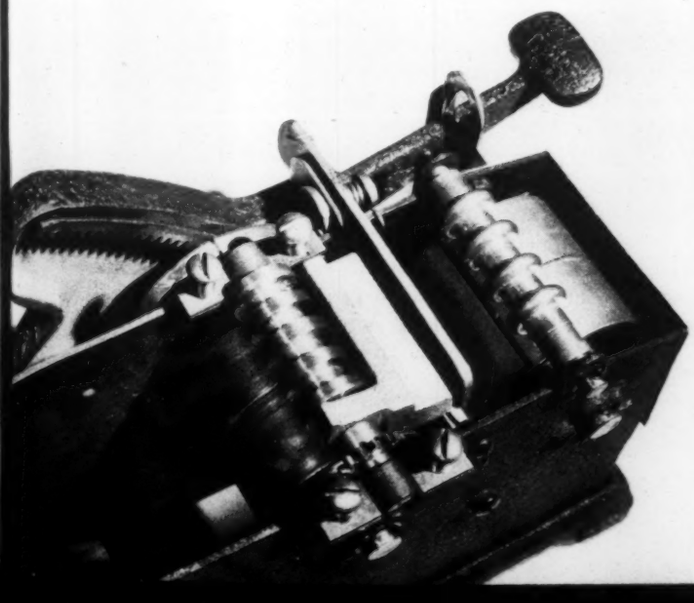
To facilitate assembly, to simplify core work on the die-cast housing and to provide for a means of varying the length of gummed tape ejected, bearings for the mainshaft are not integral with the case. They are die cast as separate flanged pieces. Integral bosses are provided for the pivot screws for the cams which operate the cut-off knife. Slots are cored for the reciprocating knife carrier and for the idler roll shaft as well as for one floating and two adjustable shoes which serve to guide the tape after it leaves the feed rolls. These shoes are themselves die cast.

### Housing Involves No Assembly

Since the main housing is in one piece it involves no assembly operations. The shoes take the place of the former idler rolls and of a stamped guide plate which had to be screwed in place. One shoe is merely set in place and the other two are similarly applied but then are fastened by a single thumbscrew acting on a bowed spring which lengthens when compressed and forms a lock. The only machine work on the entire housing is the drilling and tapping of a few holes and the reaming of the holes to fit the boss of the flanged bearing. By making these as separate pieces, their assembly over the shaft for the paper feed roll is facilitated. As one of the bearing holes is blind, one end of the shaft is hidden and the other end is threaded to receive an acorn nut which fastens the operating lever to the shaft.

Thickness of the die-cast zinc alloy frame shown in *Fig.* 4 is no greater than that of the original formed frame in *Fig.* 3, and the integral base has sections averaging about one-sixth those of the former sand-cast base. The cover, also die cast, is less than half as thick as the former sand-cast cover, and is curved to mate with the counter at the top of the housing; it has a lip at each side which hides the edge of the housing itself. This cover springs into place and requires no hinge.

**Fig. 3—Interior view of older model, showing the brass rollers, one of the gears, the gear sector and the steel knife**



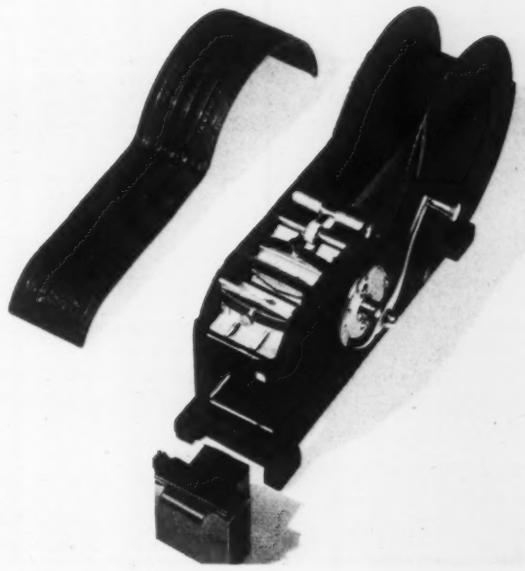


**Fig. 4—Thickness of new frame is no greater than formerly and integral base has sections one-sixth as thick**

Among the other die-cast parts, all of which are produced in zinc alloy are a hub with a grooved arm to which the lever return spring is fastened; a bracket which serves as a stop for the arm; a ratchet wheel integral with a hub, and the feed roll with its integral hub.

Stamped parts include the knife slide or carrier, the brass water tank and a support for the tank, the support serving also as an anchor for one end of the return spring. Side guides for the roll of tape are blanked from sheet metal and are approximately semicircular in shape, each with an ear which projects through a hole provided in the die-cast frame. There is a hole through the ears and when the guide plates are in place, in grooves provided in the housing, the holes come in line with holes in the casting.

In addition to being greatly superior in appearance, the new model weighs slightly less than six pounds, against 11¼ pounds for the former machine, making it easier to handle and less expensive to ship. Slightly raised flat beads provide a relief on the surfaces of the housing and cover and a black crackle finish is attractive in contrast to the bright plated parts.

---

## Plastics Institute Opens

SIGNIFICANT of the increasing importance of plastics in the engineering field is the recent opening of the Plastics Industries Technical institute at Los Angeles. All phases of plastics manufacture as well as application and fabrication will be featured in the courses. Also included in the studies will be the associated phases of design, research and sales.

John Delmonte, former instructor in plastics at Armour institute and author of "Plastics in Engineering," is technical director. Frederic Selje, formerly in charge of the design division of Chrysler Corp., is director of art and design. Dr. Paul Ivey, University of Southern California, will be director of sales research and merchandising.

# Men of Machines

GEORGE M. CLASS

INSTRUMENTAL in the appointment of George M. Class as vice president in charge of engineering of the Gisholt Machine Co., Madison, Wis., manufacturers of lathes and balancing machines, has been his wide experience in design engineering, engineering management and machine tool selling.

Mr. Class started to work for W. K. Milholland Co. in 1917 and has since devoted his entire career to the turret lathe branch of the machine tool industry. In 1924 he became associated with the Gisholt Machine company as draftsman, and worked in the engineering department for four years when he was transferred to the sales department. He returned to the engineering department in 1933 and subsequently was advanced to the position of manager of engineering. Mr. Class is responsible for many of the company's improvements in lathes and lathe tools.

JAMES S. KNOWLSON

AN EXECUTIVE well versed not only in vicissitudes of the radio industry, but also a trained mechanical and electrical engineer, James S. Knowlson several weeks ago was elected president of the Radio Manufacturers association. Mr. Knowlson is president and board chairman of Stewart-Warner Corp., Chicago.

Born in Pullman, Ill., June 29, 1883, he received his mechanical and electrical engineering degrees from Cornell in 1905. Upon graduation he entered the employ of General Electric Co. as electrical engineer. Here he remained until joining Speedway Mfg. Co. In 1934 he was elected chairman of the board of Stewart-Warner and five years later was made its president, also retaining the chairmanship. Mr. Knowlson is chairman of the board of Speedway as well.

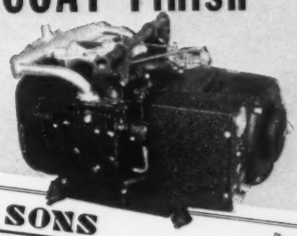
LEON BREWSTER LENT

LEON BREWSTER LENT has added another notch to his professional engineering and designing career by becoming executive secretary of the American Engineering council. A native of New York and a mechanical engineering graduate of Stevens, he began his career as draftsman for Automatic Machine Co., and later draftsman for Deane Steam Pump Co. For the next five and a half years he was associate editor of *Power*, making special studies in the power field which led to his connection with Riverside Engine Co., of which he subsequently became general manager. At the Ford Motor Co., where he held a position involving design and installation of all types of material, handling of apparatus for air conditioning systems, etc., he developed and installed large gas engines. Resigning from the Ford company he headed an organization building motor fire engines of his own design and patent which were the first to use centrifugal pumps, it is said, operated either in series or in parallel. Here he was

# *Facts* THAT CARRY CONVICTION!

## . . . as told by Satisfied Users of WRINKLE

## The ONE COAT Finish



Onan 2,000 watt generator.

The HUFFMAN MANUFACTURING Co.
AUTOMOTIVE & SERVICE STATION EQUIPMENT
BICYCLES
DAYTON, OHIO

New Wrinkle, Inc.
Mutual Home Building
Dayton, Ohio

Attn: Mr. [illegible]

Dear Mr. Ohmer:

Speaking of new Wrinkle Finish! --- Since bringing out our CRACK-L-CHROME equipment, with Wrinkle Finish, and chrome fittings, our sales of service station equipment have increased 33-1/3%.

Prior to January 1[illegible], our oil measures and dispensers were finished in Copper Bronze lacquer. However, with the modernization program of the up-to-date service station, we felt that we should do something to add eye-type finish used. Hence, CRACK-L-CHROME by Huffman!!!!

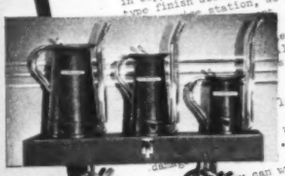
[illegible] stations to the large service centers, con-[illegible] companies, the demand is for eye-appeal. The [illegible], shown in the photograph herewith, certainly meet [illegible] been proved in our sales increase.

[illegible]f, we have had no trouble, or complaints about this [illegible] equipment is used for dispensing oil, alcohol, anti-[illegible] we have had no reports of any liquid softening or [illegible].

[illegible] can well understand why we are so enthusiastic on the [illegible] Wrinkle Finish.

Yours,
THE HUFFMAN MANUFACTURING CO.
H. J. Huffman, Jr., President

HJH:Hrkm



Oil measures and dispensers by Huffman Mfg. Company.

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ALTERNATING & DIRECT CURRENT
Electric Service Anywhere
ONAN "SAFTY-SAW
Navy Models

New Wrinkle, Inc.
Mutual Home Building
Dayton, Ohio

Att: Mr. R. F. Ohmer

Dear Sir:

We do not receive your New Wrinkles in Finishing publication, and would appreciate being placed on your mailing list to receive future issues.

I am enclosing several glossy photographs together with specifications and outline drawings, covering our new series OTC and OTA electric plants.

We believe that the finishing of these units in Baked Wrinkle is a step forward in the finishing of electric plants, or even internal combustion of the engine only for both attractiveness and durability.

Our standard finish is black wrinkle which is supplied in the case of most of the aluminum parts of which these plants are fabricated, over zinc-chromate [illegible] used. [illegible] 225 to 250 degrees, for a period of two hours.

We have found these finishes to be superior to anything else we have used, and it is well known that engines are subjected to extremely tough service conditions with hot oil and gasoline present on many surfaces, much of the time. The finish has proven to be ideal for such service.

Our units are finished after being completely finished; all screws, bolts and nuts throughout the unit are cadmium or chromium plated, and an extremely attractive unit results.

Sincerely yours,
D. W. ONAN & SONS

CWO:C

Standard
ELECTRIC TIME COMPANY
SPRINGFIELD-MASSACHUSETTS

STANDARD
ELECTRIC CLOCK SYSTEMS
EXPERIMENTAL LABORATORY WORK
ELECTRIC TELEPHONE SYSTEMS
ELECTRIC PROTECTIVE SYSTEMS
ELECTRIC PRECISION TIMERS

New Wrinkle, Inc.
Mutual Home Building
Dayton, Ohio

Attention: R. F. Ohmer, President

Gentlemen:

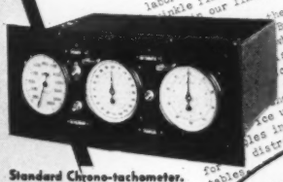
We enclose one photograph of the chrono-tachometer, one of the program clock and one which shows two pedestal type laboratory electric service units. All of these items use Wrinkle finish and we use this same finish on numerous other [illegible] our line.

[illegible]ere is sufficient description of the chrono-[illegible] Bulletin No. 99. As to the program clock, [illegible]s in schools and will sound signals on one or [illegible] schedules for different days of the week or for [illegible] of the building, sounding these signals at [illegible]ort as one minute if desired. The laboratory [illegible] are used on the students' or instructor's [illegible]ce units are used on the students' or laboratory [illegible]les in science laboratories in colleges and high schools [illegible] distributing [illegible] electric circuits to those [illegible] for [illegible] tables.

The wrinkle finish is of value to us in our manufacture for the following reasons: (1) It covers minor surface defects in metal and thereby saves sand blasting or polishing. (2) We find it to be a very durable finish. (3) It has an attractive appearance which is a necessary factor. (4) It is more resistant to acid fumes than many finishes.

Very truly yours,
THE STANDARD ELECTRIC TIME COMPANY
H. W. Angier, Assistant Manager

HWA:B



Standard Chrono-tachometer.

**Acknowledged as being among the most desirable features of WRINKLE FINISH are: ease of application . . . only one coat required to fill seams and completely cover [illegible]rface; economy of application . . . a flawless, high cost metal surface not required; gives ordinary products extra sales and eye appeal . . . and materially enhances the appearance of high grade articles; protects the product surface subject to rough usage through its exceptional durability. Every product finisher should consider the tremendous possibilities of WRINKLE FINISH. Write us for the names of our licensee manufacturing firms.**

U S Patents—1,689,892—1,732,661—1,831,383—1,864,703—1,878,316—1,883,408—1,896,594—1,936,913—1,950,417—1,969,184—1,976,191—1,980,309—1,991,527—1,991,528—2,037,331—2,069,252—2,077,112—2,124,703—2,154,954—Des. 88,001—Other Patents Pending—Canadian Patents 311,503—311,504

**NEW WRINKLE, INC.**
**DAYTON, OHIO**

# OHIO GEAR REDUCERS

*activate this*

## CONSOLIDATED

**ROTARY BAG FILLER**

The Rotary Bag Filler shown above is just one of the units built by Consolidated Packaging machinery Corporation, Buffalo, N. Y. Others of the company's machines pack many different types of products. And Consolidated engineers rely on Ohio Gears and Reducers to provide the dependable performance these machines must give.

"The reason we do so large a business with Ohio Gear", writes the company, "is that they have proved a particularly good source for gear units and other gear and sprocket parts which are somewhat off standard and are not available as stock parts from any source. Then, too, they have helped us solve many troublesome problems in parts and gear drives." You, too, will find Ohio Gear a "particularly good source" for your power transmission needs. Write for a catalog or get in touch with the nearest representative today.

**THE OHIO GEAR CO.**

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Standard Machinists Supply Co.
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George P. Coulter
322 Curtiss Building

*Minneapolis, Minn.
Industrial Supply Co.
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F. E. Allen, 2655 Main St.

*Kansas City, Mo.
Kansas City Rubber & Belting Co.
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*San Francisco, Calif.
Adam-Hill Co.
244-246 Ninth St.

Louisville, Ky.
Alfred Halliday, 330 Starks Bldg.

*Indianapolis, Ind.
A. R. Young
518 North Delaware Street

St. Louis, Mo.
St. Louis Tool Co.
2319 N. Ninth Street

*Stocks carried.*

OHIO GEARS


also responsible for an oil cooler for high-speed, high-powered gasoline engines.

In 1917 Mr. Lent joined the Aviation section, Signal Corps, and was assigned to duty developing airplane engines. At Camp Vail, N. J., he designed and used one of the earliest sandblast cleaners for spark plugs. After the war he became general superintendent of the U. S. Air Mail service, organizing the first transcontinental service. As aviation consultant he developed a fuel system for airplanes, now in use, and numbered among his clients the Aeronautical Development Commission of the state of Connecticut.

♦

F. J. Geiger has been appointed assistant manager of the electrical department of the Allis-Chalmers Mfg. Co., in which capacity he will be in charge of sales and engineering at the company's Norwood, O., plant. He succeeds C. J. Rattermann who has resigned after almost forty years' service. Mr. Geiger joined the company in 1913.

♦

R. D. MacCart, chief engineer, Brewster Aeronautical Corp., New York, has been elected vice president in charge of engineering.

♦

J. B. Baumann has been elected first president of Mercury Aircraft Co. Inc., Menominee, Mich. Mr. Baumann, formerly a member of the engineering staff of Taylorcraft Co., Alliance, O., will also be plane designer and chief engineer of the new company.

♦

Harold Caminez, connected with Allison Engineering Co. from 1929-1936 has been appointed executive engineer of Air Associates Inc. Mr. Caminez worked on the design and development of the V-1710 Allison engine, and also originated the "Aero-Thread" screw thread system which was recently introduced by Air Associates Inc.

♦

G. Taylor Stanton, previously manager of industrial applications for Electrical Research Products Inc., has been appointed chief engineer of the Tel-Autograph Corp., New York. Mr. Stanton is responsible for the design of the sound system in General Motors Futurama at New York World's Fair.

♦

E. C. Herrington, for the past five years chief engineer of Herrington & Randall Inc., Detroit, industrial oven builders and designers, has joined Ferro Enamel Corp. where he will head the company's industrial oven division.

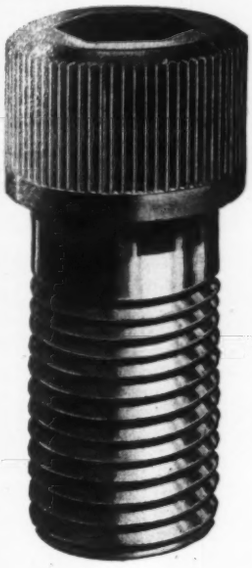
♦

C. L. McCuen who has been at the head of the Oldsmobile division of General Motors for the last seven years has been appointed vice president in charge of engineering of General Motors.

♦

G. H. Connelly, previously connected with Packard Motor Co., has been made production manager and chief engineer of Covered Wagon Co.

# For more compact designs . . . greater neatness . . . rapid assembly . . .



Specify **UNBRAKO**

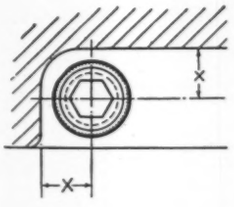
Reg. U. S. Pat. Off.

## SOCKET HEAD CAP SCREWS

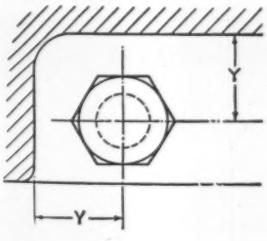
The plan views shown below illustrate how simple it is to achieve much narrower and therefore thinner flanges without sacrificing strength. Resulting compactness insures decided savings in material, weight, cost . . . increases holding power by bringing screw head closer to the joint.

The cold-forged "Unbrako" caps appeal to every mechanic because of their "Better-Grip" Knurled heads. Therefore, they not only enhance the finished appearance of equipment on which they are used but provide a non-slip gripping surface which speeds up production. And by two simple but effective methods "Unbrako" Socket Screws can be locked into place after counter-sinking in either hardened steel, cast iron or soft metals.

No other socket screw has all these unique advantages . . . specify them for your equipment!



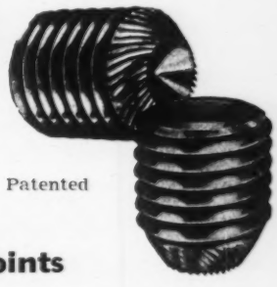

See how the Knurled "Unbrako" snuggles right into the corner.




Notice the great open spaces necessary for the hex head and wrench.

**UNBRAKO**

**SELF-LOCKING HOLLOW SET SCREWS with the Knurled Points**



Patented

## For Safety and Savings

They'll protect your machines from accidents or breakdowns caused by ordinary set screws working loose. And not only do you get extra protection but reduced machinery maintenance costs. For once set up, "Unbrako" Self-Lockers can't lose their grip no matter how severe the vibration. Yet they're easily removed or adjusted and can be used over and over again indefinitely. Investigate these, too!

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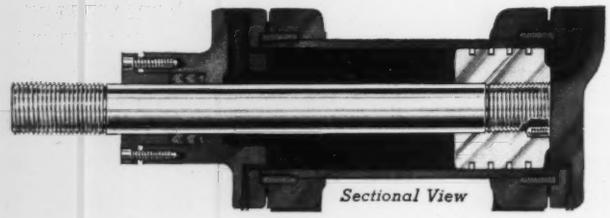
# Simpler Design for *High Efficiency* Hydraulic Power



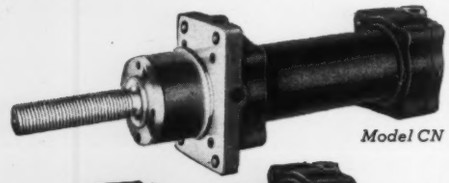
*Sectional View*

**Hannifin patented no-tie-rod hydraulic cylinder design makes the advantages of hydraulic power more practical, with easier application, high efficiency operation, and extra ruggedness to stand severe service.**

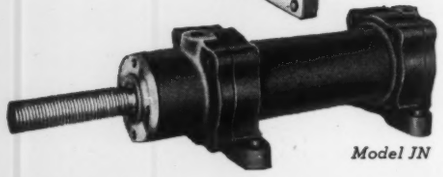
**Examine these features: No tie rods. End caps may be removed without collapse of other parts. Universal end caps. May be positioned independently, with inlet at top, bottom, or either side. Air vent plugs. Each cap has air vents on three sides. Leakproof. Precision construction with mirror finish honing of cylinder bore gives a straight, round, perfectly smooth cylinder interior—better piston seal and minimum fluid slip.**

**Construction and finish are the same in all sizes. There are seven standard mounting types, with small diameter piston rod, 2 to 1 differential piston rod, or double end piston rod. All sizes, for working pressures up to 1000 and 1500 lbs. per sq. in. Other types built to order, any size, for any pressure. Write for Bulletin 35-MD with complete specifications.**

*Other Mountings Available*



*Model CN*



*Model JN*

**HANNIFIN MANUFACTURING COMPANY**
**621-631 South Kolmar Avenue • Chicago, Illinois**

**HANNIFIN**
**HYDRAULIC CYLINDERS**


# ASSETS to a BOOKCASE

### Metals

*By Sir Harold Carpenter and J. M. Robertson; published by the Oxford University Press, New York, and London; two volumes, 1485 pages, 6 by 9⅝ inches, cloth bound; available through* MACHINE DESIGN *for $35 postpaid.*

An unusually comprehensive and ambitious book, this work aims to discuss the characteristics of all industrially useful metals and to explain how these characteristics are related to composition and treatment on the one hand and properties on the other. Arranged in logical fashion, the contents start with definitions and proceed through information of increasing complexity until a moderately complete coverage has been given of the whole subject. Naturally the book has primary importance for students but men professionally interested in metallurgy will find it helpful.

The authors acknowledge the obvious fact that knowledge about metals is increasing daily and that many points are still moot. Therefore, opinions given are those of the authors but may be taken as majority ones because experiments and views of others have been duly considered.

Most of the subject matter in the first four of the six parts relates to metals in general. Part IV, for instance, discusses casting and heat and mechanical treatment as a whole, since most of the industrially useful metals can be handled in similar ways. The final two parts cover iron, copper, aluminum, nickel, lead, zinc, tin and magnesium, and alloys based on them.

□ □ □

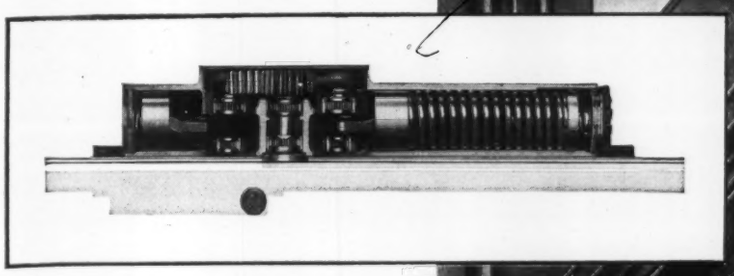
### Theory of Plates and Shells

*By S. Timoshenko; published by McGraw-Hill Book Co., New York; 492 pages, 6 by 9 inches, cloth bound; available through* MACHINE DESIGN *for $6 postpaid.*

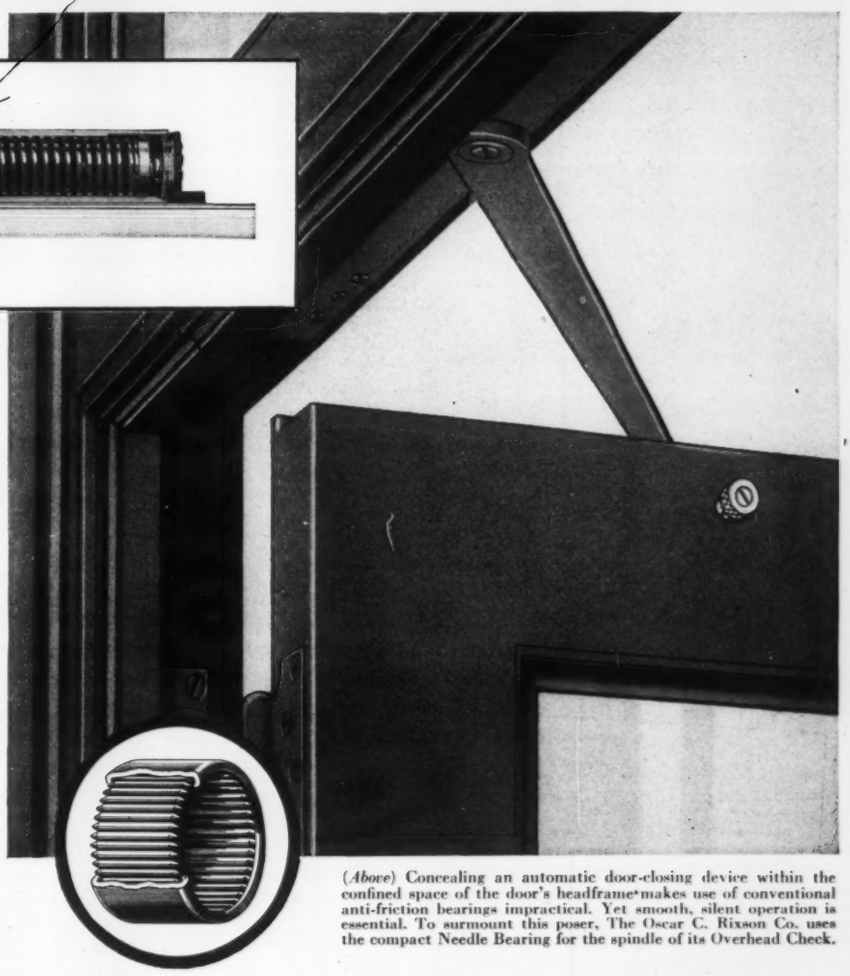
Books by Prof. Timoshenko must always be considered events in the field of mechanics. The past summer has witnessed this new volume and the second edition of a former one, reviewed below. The latter is primarily for students, while the *Theory of Plates and Shells* is written principally for engineers engaged in the design of walled structures. In the book, *Theory of Elasticity,* the author considered the deformation of bodies the three dimensions of which were of the same order of magnitude; in the present volume he discusses only problems in which one dimension of a body—i.e., the thickness of a plate of shell—can be considered as small in comparison with the other dimensions.

Most of the space is devoted to the investigation of particular problems, discussion of the general theory of plates being limited. Treatment of these problems is not restricted to the development of a general solution, but in many cases complete numerical calculations are carried out and presented in the form of tables containing the values of the deflections and

# IN THE RIXSON CONCEALED DOOR CHECK TORRINGTON NEEDLE BEARINGS MINIMIZE FRICTION IN MINIMUM SPACE



(*Above*) Cutaway view of the Rixson No. 220 Concealed Overhead Door Check, showing how the Needle Bearing permits full anti-friction operation in minimum space.



(*Above*) Concealing an automatic door-closing device within the confined space of the door's headframe makes use of conventional anti-friction bearings impractical. Yet smooth, silent operation is essential. To surmount this poser, The Oscar C. Rixson Co. uses the compact Needle Bearing for the spindle of its Overhead Check.

OCCASIONALLY, use of the Torrington Needle Bearing comes about as a result of finding it the *only* anti-friction bearing readily adaptable to some specific design problem. And having once used the Needle Bearing, alert manufacturers are quick to perceive its advantages—and thereafter, specify it wherever the opportunity to use it occurs. Take the case of The Oscar C. Rixson Company, manufacturers of improved mechanisms in builders' hardware. Let Mr. M. A. Reisel, of the Rixson Company, tell the story:

"In door-closing devices, bearings must be efficiently lubricated, as such devices, once installed, receive practically no care or attention. In order to improve the wearing qualities of our floor checks, where plain bearings had been previously used, and the *dimensions of the device could not be changed*, we arrived at the use of the Needle Bearing around the spindle.

"Subsequently," continues Mr. Reisel, "when we designed our No. 220 type of Concealed Overhead Check, we incorporated a total of six Needle Bearings in it, and *they have proven highly successful.* In this device, which is concealed within the door's headframe, it is essential to maintain as compact a unit as possible due to minimum space for the completed assembly; and yet be certain of eliminating friction. We found the Torrington Needle Bearing ideally suited to such requirements."

Ready adaptability to product design is typical of the Torrington Needle Bearing. With its small size, simple construction, ease of assembly and lubrication, it frequently permits simplification of design with resultant savings in space, weight and cost. Our Engineering Department will be glad to cooperate with you in adapting the high-capacity, low-cost Needle Bearing to *your* product. For information, write for Catalog No. 9. For Needle Bearings to be used in heavier service, request Booklet 103X from our associate, the Bantam Bearings Corporation, South Bend, Indiana.

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ESTABLISHED 1866
*Torrington, Conn., U.S.A.*

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**NEEDLE BEARING**

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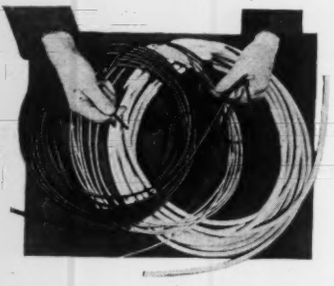
*Extruded Plastic Tubing in Continuous Lengths for Electrical Insulation in Many Industries.*



•

AGAIN IRVINGTON has pioneered in the development and manufacture of an American-made extruded plastic tubing for insulation. High dielectric strength, high mechanical strength, and hitherto unattainable resistance to tearing, abrasion, heat, fire, and solvents are its outstanding advantages in use. Advantages for the manufacturer include extreme flexibility, inside and outside smoothness, thin walls, resistance to soldering temperatures, and availability in continuous lengths. Yet this remarkable new product is low in cost.

XTE-100 is used where highest temperatures are encountered, XTE-30 for all other applications.

*Condensed Table of Properties of Irv-o-lite Extruded Tubing for Electrical Insulation

| | | XTE-30 | XTE-100 |
|---|---|---|---|
| FLEXIBILITY | Excellent at all temperatures down to | -4° F. | 32° F. |
| TENSILE STRENGTH | of No. 8 tubing, in lbs. per sq. in. | 2000 | 2000 |
| HEAT RESISTANCE | will not crack when bent over A.S.T.M. specification mandrel, after heating at 220° F. for | 120 hrs. | more than 240 hrs. |
| FIRE RESISTANCE | A.S.T.M. specification | won't support combustion | won't support combustion |
| OIL RESISTANCE | heated in transformer oil at 220° F for 48 hours | slight stiffening | slight stiffening |
| DIELECTRIC STRENGTH | volts per mil up to .022" wet<br>volts per mil up to .022" dry | 350<br>750 | 400<br>750 |
| SOLVENT RESISTANCE | both resistant to following | all petroleum solvents—benzol—toluol—denatured alcohol—acid (30% conc.)—alkalies (30% conc.) | |

*For complete data, including tests, sizes, lengths and colors regularly manufactured, uses, samples, and prices, write today for Bulletin, XTE-30 and XTE-100.

*Irv-o-lite* **XTE-30 XTE-100**

IRVINGTON VARNISH & INSULATOR CO.
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Representatives in 20 Principal Cities


stresses for various proportions of plates and for different load conditions.

Of particular help to designers are the numerous references to papers treating problems on bending of plates and shells, since these permit further study of special problems in more detail.

□ □ □

### Simple Blueprint Reading

*Published by the Lincoln Electric Co., Cleveland; 138 pages, 6 by 9 inches, fabrikoid bound; available through* MACHINE DESIGN *for 50 cents postpaid.*

Although compiled and published primarily for welders, this book contains information of value for anyone concerned with mechanical construction. A comprehensive explanation gives a clear understanding of various symbols used in the drawing of different types of welded joints. Illustrations include practical examples of drawings of a number of machine parts.

□ □ □

### Engineering Mechanics

*By S. Timoshenko and D. H. Young; published by McGraw-Hill Book Co. Inc., New York; 523 pages, 6 by 9 inches, cloth bound; available through* MACHINE DESIGN *for* $4.

Second edition of this book, primarily for students, aims to provide broad fundamental information on the subject of mechanics, while avoiding routine drill in standardized methods of solution of problems. The authors believe that in this way students will be better equipped to handle new problems as they are encountered in industry. Familiarity with various general methods of attack is also essential.

Since the first edition comprised two volumes, considerable revision was necessary for publication of the same basic material in one volume. Two major changes have been made along with the reduction of size. A chapter on kinematics of a particle has been eliminated from the section on dynamics and the material spread through succeeding chapters. Two appendixes now sum up all the material on (1) Moments of Inertia of Plane Figures and (2) Moments of Inertia of Physical Bodies.

□ □ □

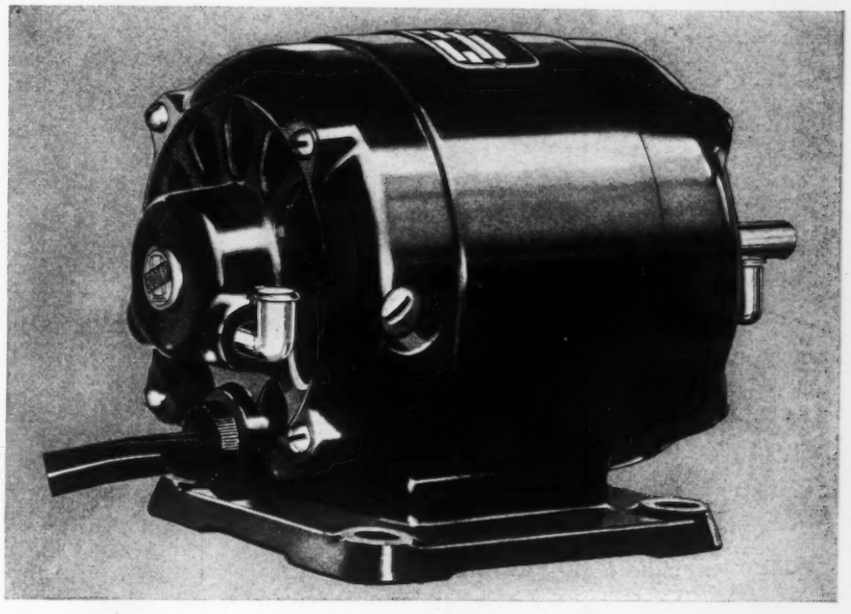
### Technical Drawing

*By Frederick E. Giesecke, Alva Mitchell and Henry Cecil Spencer; published by the Macmillan Co., New York; 687 pages, 6 by 9 inches, cloth bound; available through* MACHINE DESIGN *for* $3 *postpaid.*

Second edition of this textbook includes four new chapters, two of which reflect late trends. These deal

# Characteristics and Applications of the DIRECT-CURRENT MOTOR

*Number Three of a series on "How to Select a Small Motor for your Machine"*



*Bodine 1/40 hp Shunt-Wound, Constant-Speed D-C Motor*

Direct-current motors are of three types: series, compound, and shunt. This article will consider only shunt and compound motors, which have a larger application than series motors because of their small variation in speed between no load and full load.

*Common Uses*

Shunt or compound d-c motors, like split-phase a-c motors, are applicable to any machine which requires power at a constant speed. They are used on railroad and marine equipment, machine tools, control apparatus, and many other devices.

*Principle of Operation*

Shunt-wound motors have armatures with distributed windings and field windings of many turns of fine wire on salient poles. Compound motors, in addition, have a few turns of heavy wire in series with the armature. Electrical connection between armature and field is made through the commutator in such a manner that magnetic repulsion acting on the coils provides a constant turning force that rotates the armature.

*Disassembled view of Bodine Type N, D-C motor, showing commutator and windings*

*Limitations*

The main disadvantage of any d-c motor lies in its use of a commutator. Even the best of motors will occasionally have commutator or brush trouble, especially if dynamic braking under load or frequent reversals are necessary. Also, because of the commutator, d-c motors are generally more expensive than a-c motors.

*Advantages*

The principal advantages of shunt and compound constant speed motors are:

1. **Practically constant speed under load.**
2. **No racing or running away at no load.** Load can be released while running without harming the motor.
3. **Good starting torque**—approximately 150% of full load torque.
4. **Speed adjustability**—Motor speed may be increased or decreased by use of suitable resistance.
5. **Reversibility**—Motor connections may be interchanged for reverse rotation.


***Bodine offers D-C Motors with or without SPEED REDUCERS***

**Bodine also has a complete line of a-c and universal motors!**

**Over 3000 Types—1/2000 to 1/6 Hp**

In addition to a full line of d-c motors, Bodine also makes fractional horsepower a-c and series universal motors of all types. These are available with or without speed reducers.

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MOTORS
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Spring Handbook! Full of usable spring data. Yours for the asking!

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with Instrumental Drawing and Welding Drawings.

In general, the book is not intended as a manual for students from which drawings are to be copied, but as a comprehensive treatment of the art of technical drawing. A large group of practical problems is included. As a method of instruction, preparation of drawings from actual machines is urged by the authors.

Because the volume is written in accordance with the standard on drafting room practice which was adopted in 1935, it is an excellent reference book.

□ □ □

### Technical Drafting

*By Charles H. Schumann; published by Harper & Brothers, New York; 793 pages, 6 x 9¼ inches, cloth bound; available through* MACHINE DESIGN *for $3.50 postpaid.*

Purpose of this volume is to "co-ordinate and provide a perspective of the major branches of engineering by means of drawings, the keystone of the profession." The author emphasizes its reference value for engineers, along with its use as a textbook.

Two distinct parts make up the book, the first being a complete elementary course, the second dealing with professional drafting. To modernize the presentation, planes of projection have been omitted in demonstrating the theory on which engineering drawings are based, although the old form of the theory is explained in a separate chapter. In Part II no reference is made to planes of projection.

An important feature of the text is the large number of illustrations, all of them actual working drawings.

□ □ □

### The Story of Superfinish

*By Arthur M. Swigert; published by Lynn Publishing Co., Detroit; 672 pages, 6 by 9 inches, cloth bound; available through* MACHINE DESIGN *for $5 postpaid.*

Although this volume naturally emphasizes Superfinishing, it might fairly be called a book on modern metallic finishing, since it discusses other methods of finishing bearing surfaces. The subject is a live one, as witness the conference on surface finish held recently (M. D., July, page 46).

Parallelling the familiar weakest-chain-link axiom, the author builds his discussion on the premise that machines are only as efficient as their least satisfactory load-carrying surfaces. The book, while elementary in places, is the first to cover exclusively the subject of metallic surface finishing. As such, it is valuable for designers.

The author begins with a discussion of the importance of surface finish in modern machines, and proceeds through measurement of finishes and various ways of removing metal from surfaces to enhance smoothness. Lubrication, design of bearings, and metallurgy of machined surfaces are other subjects covered. Finally, of course, Superfinishing is discussed and its advantages outlined.

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ELECTRICAL AUTOMOTIVE EQUIPMENT

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July 25, 1940

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Business Manager
MACHINE DESIGN
Penton Building
Cleveland, Ohio

Dear Mr. Hays:

I hope you will pardon my delay in replying to your letter of June 24.

The greatest part of our filter business comes from manufacturers who design our filters into machine tools, engines and special machinery as standard equipment. This is a source of a greater sales volume than are all of our other markets combined. Our advertising efforts in this field are therefore of first importance.

We must direct our advertising in this market at the design function and we are interested from this angle in reaching only those firms and individuals concerned with the problems of designing machinery. These are the considerations which led two years ago to our selection of MACHINE DESIGN to carry our story to this field. The decision was an important one because, with our policy of doing a dominating job by using color and 2-page spreads, our appropriation permits the use of only one design publication.

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THE CUNO ENGINEERING CORPORATION

C. H. Winslow

Advertising Manager

C.H.Winslow:NB

P.S.
While on this subject, we might say that we think MACHINE DESIGN is very capably represented by Mr. Smith.

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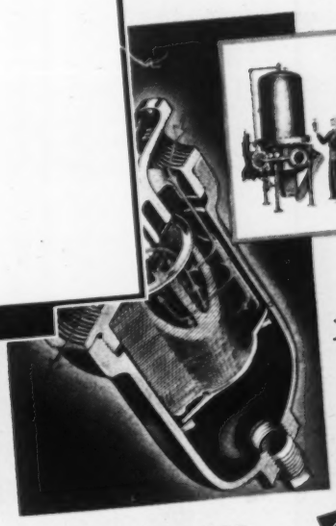

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6. Size, construction and degree of filtration to fit your needs.

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In the design of a 145 horsepower diesel, only a tiny space was available for a built-in filter. Yet a compact Cuno, with ample capacity to handle the full flow of lubricating oil, was easily designed into the crankcase.

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*Efficient Non-Interrupted Fluid Cleaning*

### THEIR CHOICE IS A TROUBLE-FREE

Aircraft designers have built Cuno Filters into practically every leading make of airplane and engine—a tribute to Cuno's dependability, light weight and compactness.

Designers of machine tools, engines,

### SUGGESTION FOR OPERATION

fluid handling equipment, lubrication systems, etc., are turning to Cuno in increasing numbers, because a Cuno "continuously cleanable" Filter means *positive* fluid cleaning, *uninterrupted* production and *minimum* maintenance costs.

KEEP ON GO WITH CUNO

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1. This is one of a stack of *discs*, held apart by
2. Spacers, whose thickness determines the degree of filtration.
3. Discs and spacers are mounted on a *central rotatable shaft* which has a handle.
4. Mounted on a stationary rod alongside the shaft are *cleaner-blades*, slightly thinner than spacers, extending into the slots between the discs.
5. Fluid containing solids passes between discs, and solids larger than the aperture are retained on the outer edges.
6. Turning the handle rotates the discs past the stationary cleaner blades, combing out accumulated solids, whence they fall into the sump, to be drained when convenient.

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**Prove for yourself that Bristos give you *faster, easier, stronger, tighter set-ups!* . . .**

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Lock-tight socket head, won't split, shear, round out, jam or strip . . . Set tighter with less effort. . . . No loosening under vibration. Take wrench without fumbling or skidding. **Designed by engineers for engineers.**

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WATERBURY, CONN.

Send me sample Bristo Socket Screws in the following sizes_____ (State Sizes)
Also send me Bulletin 83-8N.

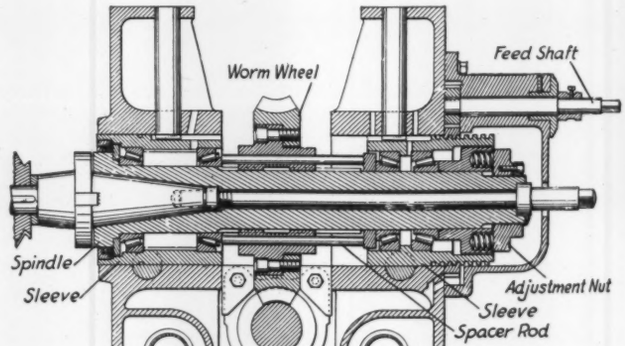
Name_____

Address_____


# *Noteworthy* PATENTS

## One Adjustment Preloads Bearings

TWO duplex pairs of tapered roller bearings are simultaneously preloaded by tightening one adjustment nut in the milling machine spindle assembly illustrated. Preload is transferred through the springs and spring housing to the cone of the first bearing, thence by way of the bearing sleeve to the cup of the second bearing. The cones of the inside bearings of the duplex pairs are connected by means of spacer rods which pass through clearance holes in the driving worm wheel. The two bearings on the




*Milling machine spindle with preloaded bearings is capable of axial adjustment*

cutter end of the spindle are thus preloaded by the thrust of these bars. Spindle and bearing assembly are self contained and are guided in the housing by the sleeves.

Axial adjustment of the milling cutter is possible with this design and is provided for by threads cut on the rear sleeve. Spur teeth cut on the outside surface of the nut which runs on these threads permits the spindle to be fed either to the left or right by turning the feed shaft. The worm wheel is splined to the spindle so that the latter may move axially without disturbing the worm and wheel relationship. The patent is assigned to the Davis and Thompson Co.

## Pipe Joint Has Floating Flanges

FLANGE union, requiring no finishing of the facing flanges, consists of two frustro-conical gaskets of mild steel or other ductile metal, two annular rings or flanges, and a guide ring. The joint requires no ma-

# *Answers to* WHO IS DOING WHAT *with*

RELIANCE V*S DRIVE

**AN ALL-ELECTRIC ADJUSTABLE-SPEED DRIVE FOR A-C. CIRCUITS**

SPEED RANGES UP TO 12 TO 1
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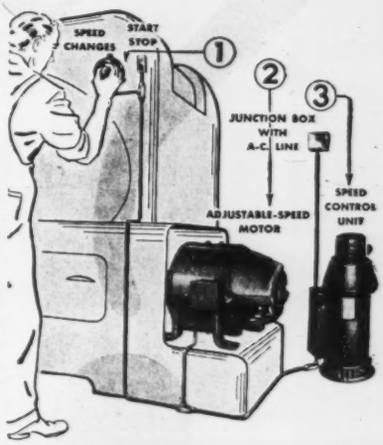
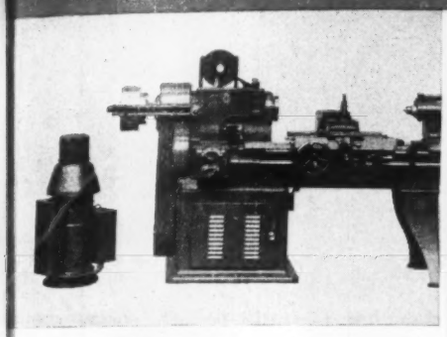
Starting, stopping and speed changing are controlled from any point to which a wire can be run.

**2. A SPACE-SAVER**
Power is applied where you want it without an intervening speed-changing device.

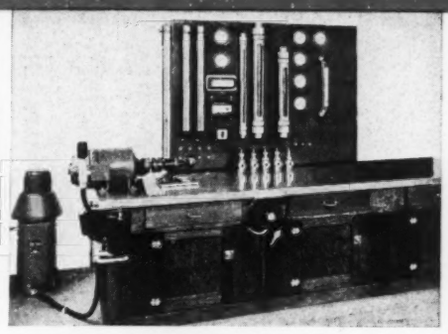
**3. FROM A-C. SUPPLY**
The advantages of this drive are now made possible at a new low price by the "packaged" V*S Speed Control Unit, connected by three wires to the 3-phase a-c. power circuit; it can be mounted anywhere.



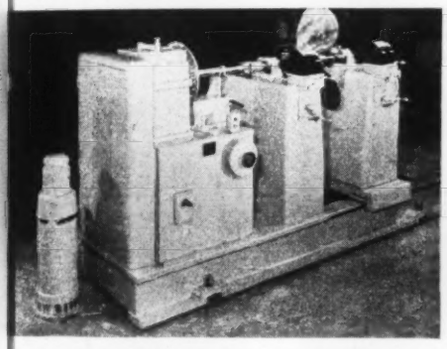

ALSO—Quick stopping, speed setting, reversing, safe speeds for threading and inching, ample starting torque for all conditions. Write for Bulletin 307.



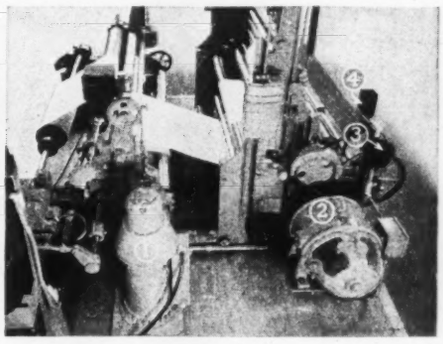
**LATHE:** A lathe builder gives machine-tool users something really new in this machine designed to make full use of the advantages offered by the Reliance V*S Drive.



**TEST BENCH:** Air transport companies use test benches like this to put pumps, magnetos, and generators through rigorous tests. Speeds range from 100 to 4200 rpm.

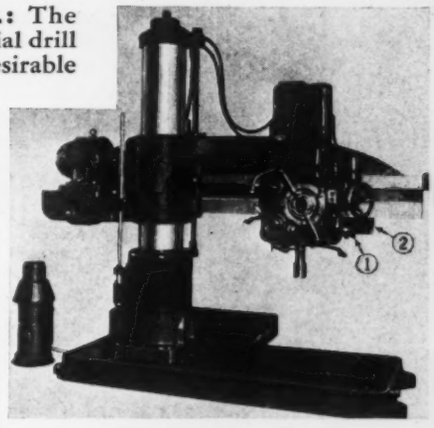


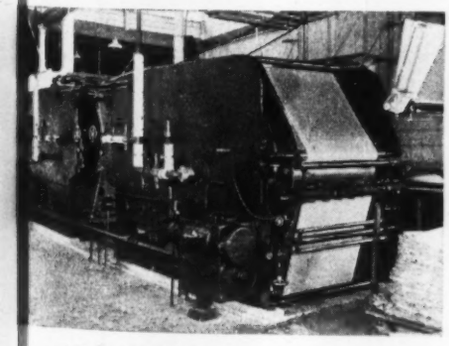
**BALANCING MACHINE:** An engine builder uses a V*S Drive on this machine designed for balancing propellers. A turn of a handle gives smooth changes in speed over a wide range.



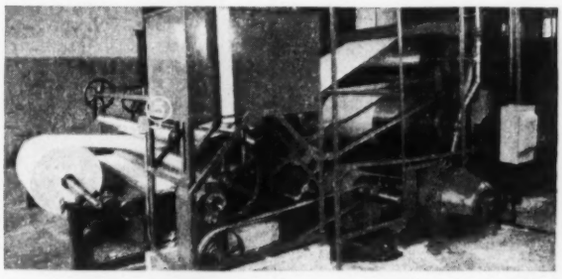
**WINDER:** A manufacturer of winders uses a 7½ hp. 1150/148 rpm. drive. Gets a low speed for threading and a top speed for the highest rate at which the roll can be wound.

**RADIAL DRILL:** The buyer of this radial drill gets all the desirable features of an easily-controlled adjustable-speed drive because the builder equipped it with a 7½ hp. V*S Drive. ➔

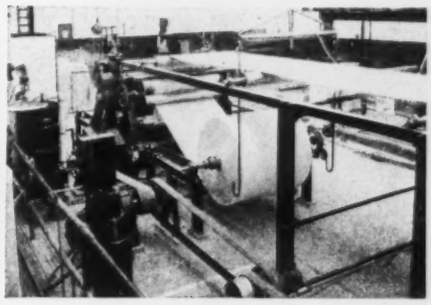




**SANFORIZER:** Makers of processing equipment such as this Sanforizer use the V*S Drive because it provides the desired operating speeds to suit a variety of materials. Also because it's easy to control starting, stopping and speed changing at points remote from the driving units.



**WAXING MACHINE:** A waxing machine manufacturer added buying appeal to his machine by using a 15 hp. 1750/218 rpm. V*S Drive. Waxing is done at higher speeds; smooth acceleration eliminates paper breaks.



**LAMINATING MACHINE:** A fibreboard plant uses a 15 hp. 700/87 rpm. drive for a laminating machine.

**RELIANCE ELECTRIC & ENGINEERING COMPANY**
1079 IVANHOE ROAD • CLEVELAND, OHIO

BIRMINGHAM • BOSTON • BUFFALO
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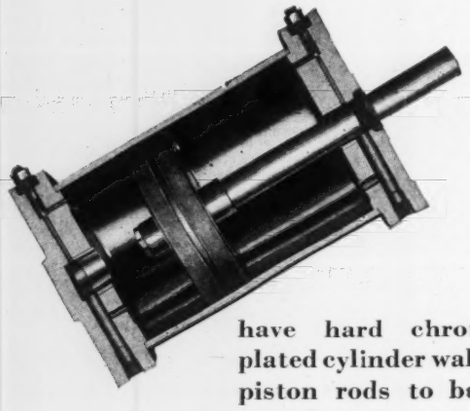
PITTSBURGH • PORTLAND (ORE.)
ST. LOUIS • SAN FRANCISCO • SYRACUSE (N. Y.) AND OTHER PRINCIPAL CITIES

**RELIANCE A-C D-C MOTORS**

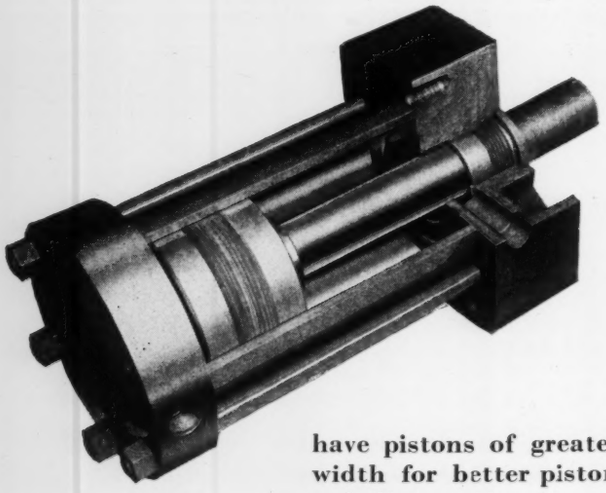
**T-J AIR CYLINDERS**
(cushioned type shown)



have hard chromium plated cylinder walls and piston rods to be protected against wear and against rust.

Packings are used which are self sealing and require no time-out periods for adjustment.

**T-J HYDRAULIC CYLINDERS**
(cushioned type shown)



have pistons of greater width for better piston rod alignment.

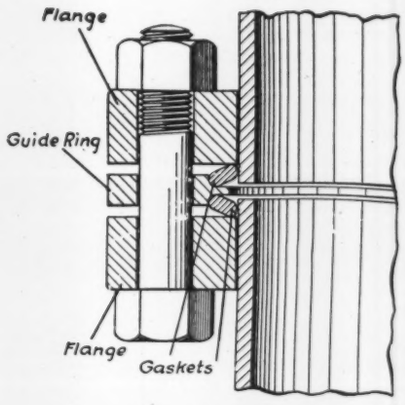
"V" type leather packings are used which create much less than the usual amount of friction and at the same time do an excellent sealing job.

*Write for Information*

**THE TOMKINS-JOHNSON CO.**

618 N. Mechanic St. Jackson, Michigan

*Agents in Principal Cities*

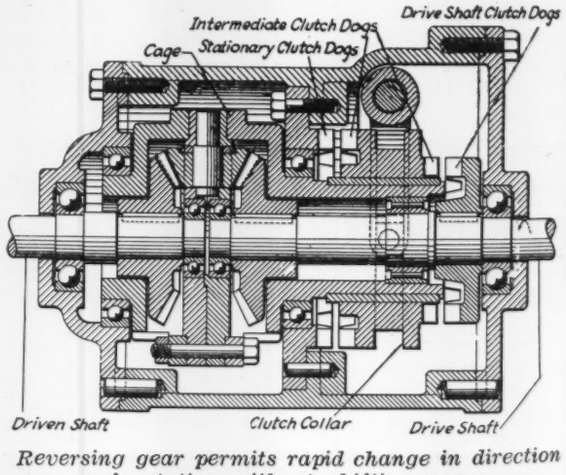

*Gasket toggle action holds pipe ends together and also seals the joint*

chining of the pipe ends except optional toothed serrations on the outside of the pipes near the mating ends. The flanges and the guide ring are drilled for the holding bolts. Since these three parts fit loosely around the pipe, ease of alignment for bolting is assured. The toggle action of the gaskets, by reducing the bolt load for sealing, permits the use of only enough bolts to resist axial movement of the pipes. The patent is assigned to The Lummus Co.

## Differential Provides Reversibility

REVERSING mechanism without change gears permits rapid reversal of the driven shaft. Designed primarily for marine service, the transmission is equally applicable wherever inertia loads are comparatively low.

The mechanism consists essentially of a conventional differential with the cage extended back around the drive shaft. A clutch collar is splined to the external cylindrical surface of this cage extension so that it may be moved to the right to engage the drive shaft




*Reversing gear permits rapid change in direction of rotation without shifting gears*

clutch dogs, or to the left to engage the stationary clutch dogs. In the intermediate position shown no power is transmitted to the driven shaft.

When running "forward," with the collar moved to the right and engaging the drive shaft clutch dogs, the

# MAGNETIC MOTOR STARTERS

You build into your machines every tested aid to *assured performance.* Make sure of it at the starting-point! — the motor starting SWITCH. The starters illustrated here give tested protection to motor, machine and operator. 50 years of fine switchmaking culminate here, — in soundness of principle, precision of mechanism, convenience of operation.

The line provides for local *and* remote control. Local control starters may be operated from remote points through Push Button Stations or other master devices, as well as by the push buttons at the starter. This permits handy control of mechanical linkages involving separate functions or sequences of machine operations.

*FEATURES:* ACROSS-THE-LINE TYPE (TYPE MC); HAND RE-SET, LOCAL OR REMOTE CONTROL. UNDER-VOLTAGE RELEASE; OVERLOAD PROTECTION BY INTERCHANGEABLE THERMAL HEATERS OF THE BI-METALLIC TYPE, ACCURATELY CALIBRATED FOR ANY SIZE MOTOR WITHIN RATED CAPACITY. SINGLE OR POLYPHASE: 110, 220, 440, 550 VOLTS; 25, 40, 50, 60 CYCLES; OTHER FREQUENCIES IF SPECIFIED. STANDARD HOUSING: STEEL BOX, MACHINE GRAY FINISH. ALSO WEATHERPROOF AND SPECIAL HOUSINGS FOR HAZARDOUS LOCATIONS.

Catalog No. 8-M brings descriptions and data you'll want. And please make use of our Free Engineering Service for practical arrangements of ARROW-H & H *Standard* Units to meet your *special* problems in motor control.

INDUSTRIAL CONTROL DIVISION

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD, CONN., U. S. A.

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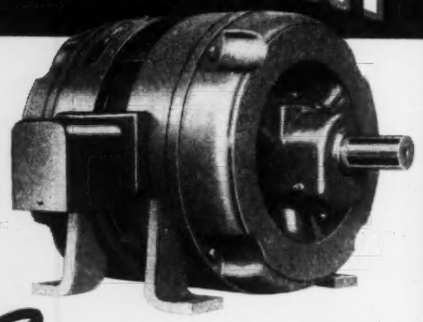
RIGHT PRICES
COURTEOUS
TREATMENT



Since 1889

THE MOTOR . . . Look at it. Can you suggest a better engineering design? A beauty to look at, efficiently designed, and packs as much power as the best. Built for any class of service that a Motor can be applied to, in sizes from 1 to 300 HP. Our engineers designed these motors around quiet-operation without sacrificing any desirable characteristics.

We have been in business 51 years and are still a small concern . . . big enough to give service and small enough to eliminate red tape. You can get to the men behind the guns (the owners of the organization) in person, by telephone, by telegraph, or by letter.

You might call it a slogan but we call it a business creed — QUALITY, SERVICE, RIGHT PRICES, and COURTEOUS TREATMENT. That goes now and has gone for a great many years. Write for Bulletin 1020, "A Service to Manufacturers Who Build Motor-Driven Machinery."

Imperial

THE Imperial ELECTRIC CO.

Manufacturers of Electric Motors and Generators, 1 HP. to 300 HP. in all modifications

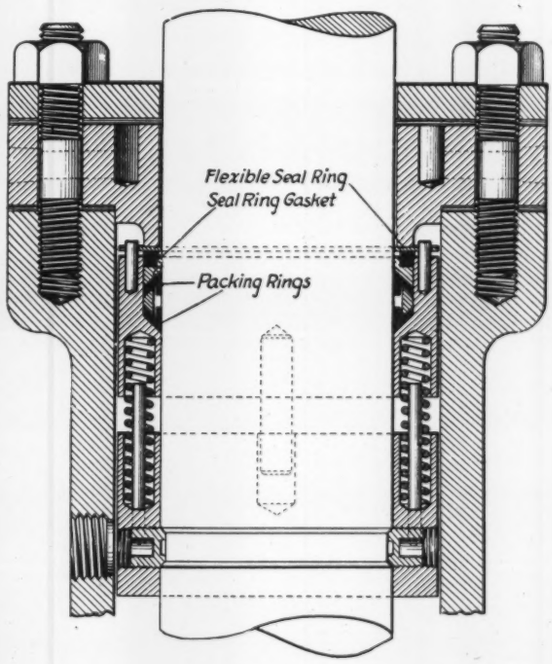
AKRON, OHIO

differential cage is locked to the drive shaft and rotates the driven shaft at the same speed and direction. When running in "reverse," with the collar engaging the stationary clutch dogs which are integral with the housing, the cage is held stationary and the driven shaft is rotated through the differential at the same speed as the drive shaft, but in the opposite direction. The patent is assigned to the Weskenson Corp, Providence, R. I.

## Seals Fluctuating Pressures

DESIGNED particularly for service in which the pressure of the sealed fluid may fluctuate above and below atmospheric, the shaft seal illustrated permits small axial movements of the shaft without detracting from the sealing efficacy.

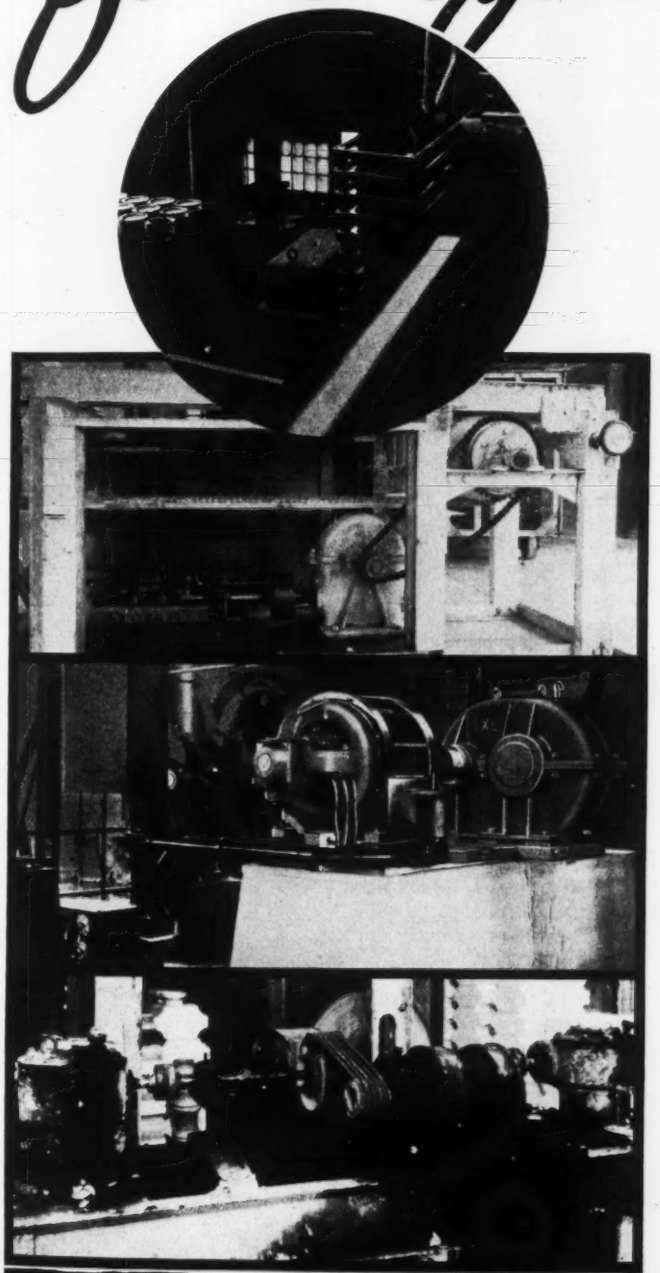
Compressor shafts are ordinarily designed to permit a small amount of endwise "float" to allow for expansion or contraction due to temperature changes. When




*Double packing rings afford seal for pressures above and below atmospheric*

the crankcase gage pressure fluctuates between positive and negative the effect of this pressure on the cross-sectional area of the shaft where it passes through the seal results in axial motion. The design of the packing rings in the illustrated seal is such that as the crankcase pressure passes through zero the pressure exerted on the shaft by the packing rings is released, permitting the springs to adjust the seal faces to the new position of the shaft. The upper packing ring is effective in sealing crankcase pressures above atmospheric and the lower in sealing pressures below atmospheric. The higher absolute pressure, applied behind the hook of its packing ring, seals the joint. The patent is assigned to the Frick Co., Waynesboro, Pa.

# IXL SPEED REDUCERS *for Defense*



## OF PRODUCTION SCHEDULES!

EVERY day . . . every hour . . . every minute counts in this big job that industry has before it. Your plant has its part to play — a vital part! Maybe not guns or ships, or tanks, but something which industry depends upon. Something we *all* depend upon. That "something" you supply must fit into production schedules that are growing faster—faster.

That problem is the reason why you'll want to incorporate into the machines you build, Speed Reducers that can be depended upon not to cause trouble and wasted hours. It's the reason we'd like to remind you that IXL Speed Reducers and gearing will keep things continually humming. They'll safeguard the quality and dependability you put into your products.

Let us go over your requirements with you.

**FOOTE BROS.**
**GEAR AND MACHINE CORPORATION**
Established 1859

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*Valuable Handbook Free!*

*Send for this valuable 600 page handbook "Gear Problems." Free to executives and engineers.*

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MUST HOLD AND PROTECT
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WORTHY OF THIS
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Whether you work with pencil or ink, you'll like the surfaces of Arkwright tracing cloths. Arkwright Tracing Cloth for ink work has a dull finish on one side which promotes the free, even flow of drawing ink in clean, unfeathered lines – a glazed finish on the other that keeps the cloth crisp and fresh.

Arkwright Pencil Tracing Cloth is primarily for pencil work. Both sides have a newly perfected rough surface with a "tooth" that takes sharp, clear pencil lines, and beautifully clean ink lines as well! Avoid lines that blur or feather by insisting on Arkwright – made by America's oldest tracing cloth manufacturer! Arkwright Finishing Co., Providence, R. I.

Arkwright
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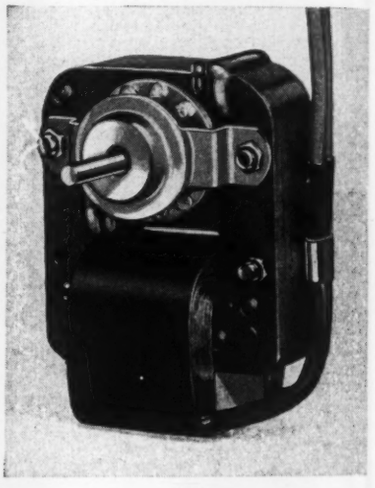
# New PARTS AND MATERIALS

## Motor Power Increased Four Times

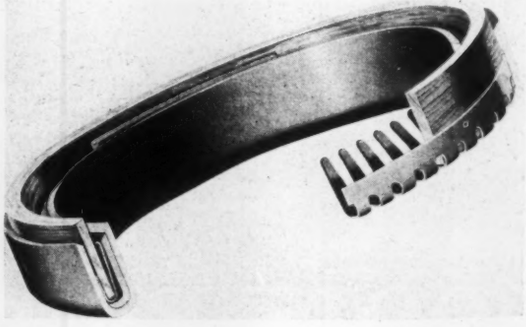
MODEL K shaded-pole induction motor announced by the Alliance Mfg. Co., Alliance, O., delivers about four times as much power as the previous similar model MS. A maximum continuous duty rating of 1/100-horsepower is obtained. Two-pole design is used, providing rotor speeds at no load of approximately 3450 revolutions per minute. Starting torques range upward to 2¼ inch-ounces, with maximum running torques 1 1/3 higher than starting torques.



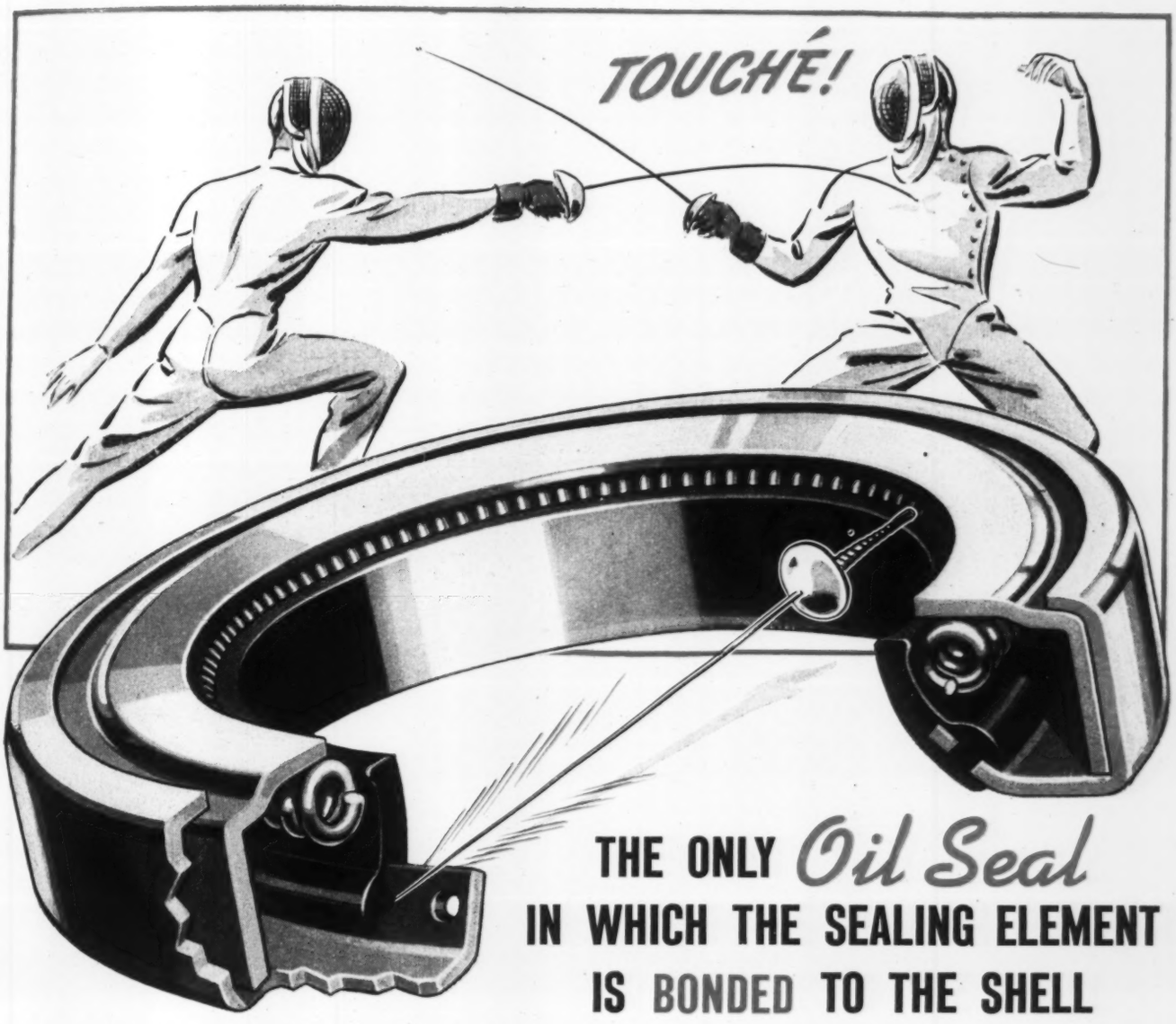
*Maximum continuous duty rating of one-hundredth-horsepower is obtained in shaded-pole motor*

## Announce Reinforced Packing

REINFORCED hydraulic packing announced by Wayne Davies Packings Inc., 325 West Huron street, Chicago, is designated double "U" because the wear wall and heel are doubly reinforced against wear on the contact leg and against pinch from excessive clearance between plunger and gland ring. This packing can be re-



*Phosphor bronze spring spacer in reinforced hydraulic packing maintains light pressure against inside of bevelled contact lip*




# THE ONLY *Oil Seal* IN WHICH THE SEALING ELEMENT IS BONDED TO THE SHELL

**THE VICTOPRENE CATALOG**

Write for a copy of the latest Victoprene catalog. Shows the range of sizes and applications for this leading oil seal.

• Like the skilled fencer, Victor has scored many important points in the development of oil seals.

Touché! Only Victor vulcanizes the sealing element to the metal shell—thus holding the Victoprene sealing element truly concentric to the shaft. The sealing element is further anchored through the steel shell by a series of small holes.

Touché! No clamping device is needed to prevent the sealing element from turning with the shaft.

Touché! There can be *no leakage* through the structure of the Victoprene Oil Seal.

Only Victoprene Oil Seals offer you these advantages.

If you have a shaft-sealing problem, we invite you to consult us. Victor Manufacturing & Gasket Co., P. O. Box 1333, 5750 Roosevelt Road, Chicago, U. S. A.

WORLD'S LARGEST GASKET MANUFACTURER

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SHEET PACKING • GASKET COMPOUNDS

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**+ Lewellen Variable Speed Control**

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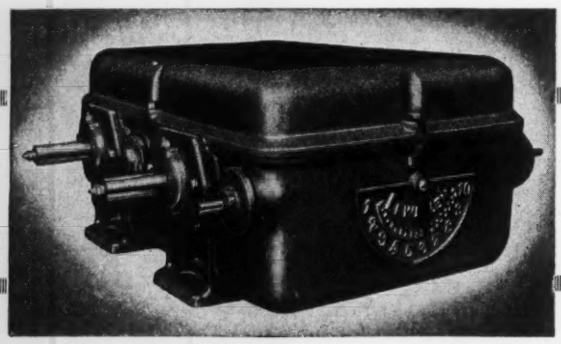

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*as an integral part* **of your equipment!**

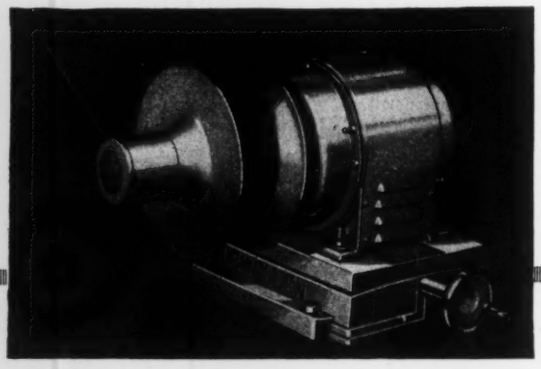
Think of your buyers—the actual users of your machines. Are you certain that they get "the best" from your equipment? To them "the best" means not only top-notch machine efficiency but complete production capacities. Accurately maintained speeds even to a fraction of an r.p.m. usually mean improved performance, increased output and a better product. Investigate the exclusive, outstanding features of Lewellen Variable Speed Control—then you'll know why it is preferred by users everywhere. Increase the sales possibilities of your machines by including either a Lewellen Variable Speed Transmission or Motor Pulley as one of the important parts of your equipment. *Let us show you how we can help you!*

**New catalogs describing Lewellen Variable Speed Transmissions and Lewellen Variable Speed Motor Pulleys are yours for the asking.**

**LEWELLEN MANUFACTURING CO., COLUMBUS, IND.**

**Lewellen knows speed control**

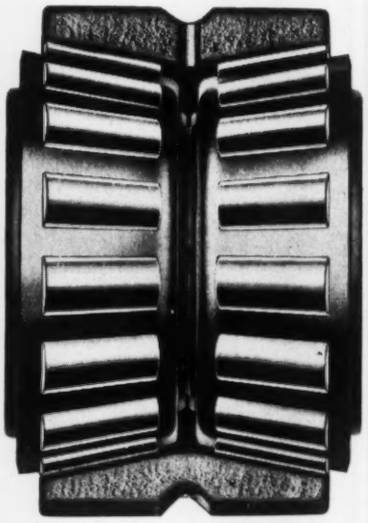
●




inforced with any adaptable material over the "U" packing base. The phosphor bronze spring spacer maintains a light pressure against the inside of the bevelled contact lip, near its pressure edge, insuring a primary seal until the packing lips can be set to the plunger surface under pressure so as to carry the seal to the packing heel. The white oak spacer is steam bent to the packing channel, forming the frame to which the phosphor bronze spring is secured.

## Roller Bearing Is Modified

ESPECIALLY adapted to serve as a sheave bearing, a modification of the standard NA type, or non-adjustable roller bearing, is announced by Timken Roller Bearing Co., Canton, O. It is made up of a double row outer race and two single row inner races or cones. Front cone faces are slotted and chamfered to provide an entrance for lubricant to within the bearing. The problem of sealing the bearing chamber has been greatly simplified by extending the length of the large cone rib and creating a surface concentric with

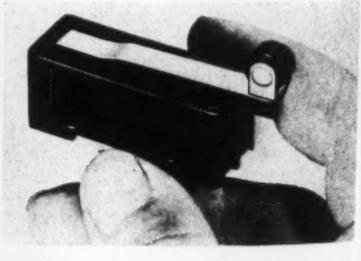


*A double row outer race and two single row inner races or cones make up non-adjustable roller bearing for sheaves*

the shaft and sheave bore on which a seal may be run. These seals have the same outer diameter as the cup and are pressed into the sheave bore and thus are used to hold the bearing together during assembly. Being an antifriction thrust bearing as well as an antifriction radial bearing, the sheaves may rotate freely without axial float.

## Develop Roller Actuator for Switch

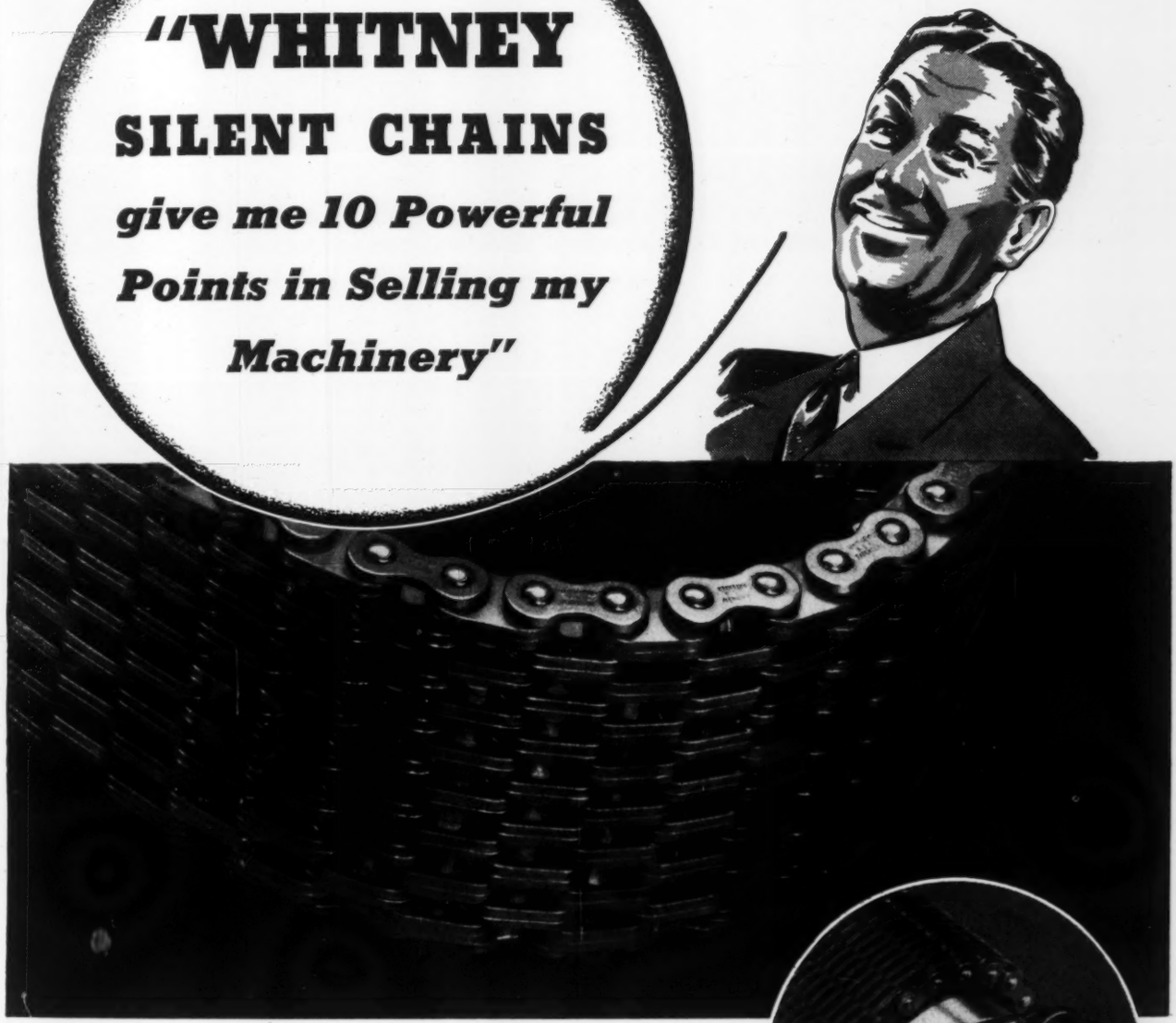
SCOPE of application of the switch is greatly increased by development of a type W spring leaf and roller actuator by Mu-Switch Corp., Canton, Mass. This actuator comprises a strong phosphor bronze spring



*Spring leaf and roller actuator increases scope of application of small switch*

securely riveted at one end to the Mu-Switch cover and having at its free end a U-bracket which holds a ⅜ by ¼-inch roller of graphite-impregnated bakelite. The

# "WHITNEY SILENT CHAINS *give me 10 Powerful Points in Selling my Machinery"*



Here are the reasons why so many machine manufacturers use Whitney Silent Chains for power drives:

1. Positive power; no slip.
2. Full machine output maintained.
3. Uniform quality of production due to uniform speeds.
4. Lower rejection rate.
5. Far longer life, due to pin-and-bushing, double-bearing construction and case-hardened wearing surfaces.
6. Uninterrupted service; frequent adjustments not needed.
7. Easy to connect and disconnect.
8. Shock and overload capacity, from tough alloy steels.
9. Not affected by atmospheric conditions; can be enclosed against grit.
10. Adaptable to varied service conditions; wide range of drive selections.

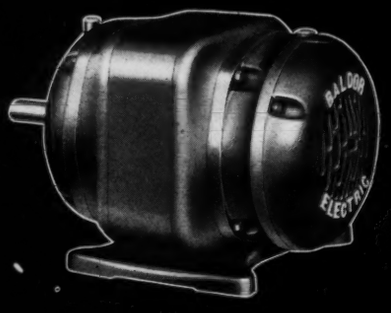
For these same reasons, *you* will find it profitable to include Whitney Silent Chain Drives in the machines you build . . . and specify them for power drives throughout your plant. *Write for Catalog V-135.*

***WHITNEY PRODUCTS*** **Roller Chain & Sprockets, Silent Chain & Sprockets, Conveyor Chain & Sprockets, Roller Chain Flexible Couplings, Automatic Load Limiting Sprockets, Automatic Drive Tensioners, Woodruff Type Machine Keys and Cutters.**

# WHITNEY CHAINS

THE WHITNEY CHAIN & MFG. CO., HARTFORD, CONN.

THIS BALDOR
YEAR-AHEAD
MOTOR



will add
EXTRA SALES FEATURES
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STREAMCOOLED. Provides a ball bearing totally enclosed protected motor with a non-clogging cooling system.

GLASS INSULATED. Permits more horse power in the same space and longer life under abusive service.

NO EXTRA COST. Baldor streamcooled motors, in either standard insulation or glass insulation at ordinary open motor prices.

Many other features explained in BALDOR Bulletin No. 202. Ask for it.

BALDOR ELECTRIC COMPANY, ST. LOUIS
Representatives in Principal Cities

BALDOR
BETTER MOTORS

self-lubricating properties of the roller permit extremely close bearing tolerance with resulting accuracy of cam-controlled action.

## Hanger Bearings Announced

HANGER ball bearings for screw conveyors are announced by Stephens-Adamson Mfg. Co., Aurora, Ill. Fitted with standard Sealmaster seals, these bearings have permanent lubrication. Bearing housings are

*Bearing housings in hanger ball bearings for screw conveyors are Meehanite for maximum strength*

Meehanite for maximum strength in a minimum size casting. All parts of the bearing proper except the bronze alloy retainer are specially treated to resist rust.

## Roller Plunger Available on Switch

ROLLER type plunger is now available on diecast micro switches made by Micro Switch Corp., Freeport, Ill. A sturdy castellated brass bushing accepts the roller either longitudinally or cross-wise. Long life and precision performance for this type of actuator are assured by accurate concentricity of the hardened and

*Sturdy castellated brass bushing accepts roller either longitudinally or cross-wise in diecast micro switch*

ground roller, carried on an oilless bearing. Switching element of the unit is the basic micro switch, rated at 1200 watts up to 600 volts alternating current. It may be furnished with normally closed, normally open, or double-throw contacts.

## Regulator Gives Constant Current

LATEST development of the Wagner Electric Corp., 6400 Plymouth avenue, St. Louis, is the type Y-H constant current regulator, a compact unit assembly comprising the regulator and controller-protector switch. The regulator has no moving coils but operates from no load to full load, immediately adjusting its output voltage to varying load conditions without

# AVAILABLE...

A limited number of copies of MACHINE DESIGN's 1940-1941 Directory of Materials are available. More than 500 different materials in scores of grades used in the design of machinery, are listed, briefly described, and their makers indicated.

The Directory is divided into nine convenient sections: iron, steel and nonferrous alloys; plastics and other nonmetallics; iron, steel and nonferrous alloy producers; plastics and nonmetallics producers; stampings producers; forgings producers; die castings producers; custom molders; and producers of machine finishes.

Each listing of material has a helpful key to principal characteristics, permitting quick and easy reference to those materials for which an engineer may be searching. Below is a scale of prices for quantities. Single copies are twenty-five cents, postpaid.

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| 10 Copies @ 20c per Copy | $2.00 Postpaid |
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Send all orders to MACHINE DESIGN, Book Department, 1213 West Third Street, Cleveland, Ohio.

**With the New Ozalid Model "F"**

No waiting for prints with the new fast-printing Ozalid Model "F" Whiteprint machine. By actual tests with an average pencil tracing 18" x 36" . . . 38 seconds in the printer and 54 seconds in the developer.

Printing speeds up to 56 inches per minute and absolutely even light distribution with the new high pressure mercury vapor lamp used in the Model "F" . . . no flickering, no streaky prints, and no carbons or globes to change.

Plenty of light to print Ozalid transparent papers, cloths, and foils. What's more, you cut electrical consumption as much as 50%. Yet, the Model "F" is so compact that it can be conveniently installed in any print room, drafting room, plant or office.

Here is a machine that saves in labor too, since one operator can easily handle capacity production. Avoid washing and fixing, drying and trimming of prints. When the finished Ozalid print emerges from the Model "F", it is dry, true-to-scale, and ready for immediate use.

*Send for Model "F" circular and free booklet of dry-developed Ozalid prints. There is no cost or obligation.*

**ONLY OZALID HAS DRY DEVELOPMENT**

Ozalid CORPORATION
ANSCO ROAD · JOHNSON CITY, NEW YORK
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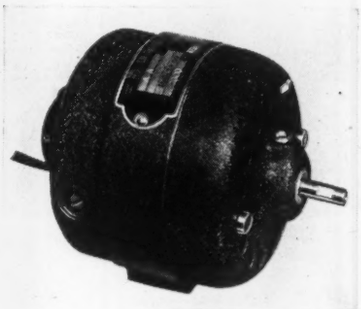
surges on the line, and is consequently adjusted instantaneously with changes in load. Because of the low current-draw, the supply-line drop is very small. This regulator is particularly suited to applications requiring constant current at all loads, such as flasher signs for advertising.

## Improve Universal Motor Line

IMPROVED types AA and A3A motors with self-aligning bearings replace the A and A3 motors in the fractional horsepower line of universal motors made by the Dumore Co., Racine Wis. Ball bearings or sleeve bearings may be furnished in the same housing without change. Oil capacity in the bearing bosses has been enlarged, and the A3A motor is equipped with a heavier shaft. The AA motor has larger brushes and an improved brush plug which is flush with the motor housing, minimizing the possibility of breakage. Black crinkle finish is used on these motors.



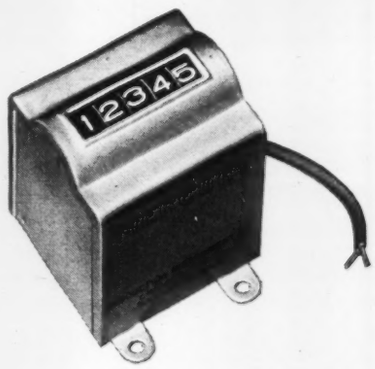
*Ball or sleeve bearings are furnished in same housing of fractional horsepower motors*

## Timer Accurate over Broad Range

A UNIVERSAL interval electronic timer, accurate over ranges from 1/20-second to two minutes is announced by Photoswitch Inc., Cambridge, Mass. Control is accomplished through a specially designed snap-action relay of 1000-watt capacity. Both momentary push-button and sustaining contacts may be used for actuating control. The timer is universal for six timing ranges represented by six valves snapped into a readily accessible clip.

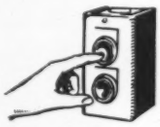
## Small Electric Counter Developed

A SMALL electric counter has been developed by the Production Instrument Co., 708 West Jackson boulevard, Chicago. The Mercury counter has a small energy requirement—two watts at rated voltage—which insures long life to switch contact points. The small instrument has a case and frame of cadmium-finished steel with unbreakable plastic windows. Five number




*Small energy requirement of counter insures long life to contact points*

# • IT'S ATTRACTIVE
# • IT'S COMPACT
# • IT'S STURDY
# IT'S BUILT FO



Here's a new push-button station that combines attractive appearance with ability to take the hard knocks imposed by machine-tool duty. As evidence of its practical design, note these details:

1. All-steel enclosing case. Removable cover makes three sides accessible for wiring.

2. Raised guard rings make $\frac{7}{8}$-in. buttons easy to "locate" with the finger—also prevent accidental operation.

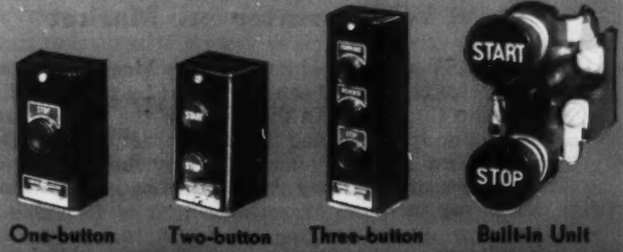
3. Good contact on every operation is assured by heavy $\frac{3}{16}$-in. fine-silver contacts, which *roll* closed and *roll* open.

4. Sturdy operating springs prevent accidental operation due to machine vibration—assure against "contact freezing."

5. Push-button unit is *back mounted* on rear of case so that excessive pressure on button will not cause misalignment.

These and its many other features adapt this station especially for use on machine tools, or wherever a compact, attractive, durable station is required. The coupon will bring literature. General Electric Co., Schenectady, N. Y.

**COMPLETE LINE**




One-button · Two-button · Three-button · Built-In Unit

*General Electric, Section C 676-21*
*Schenectady, N. Y.*

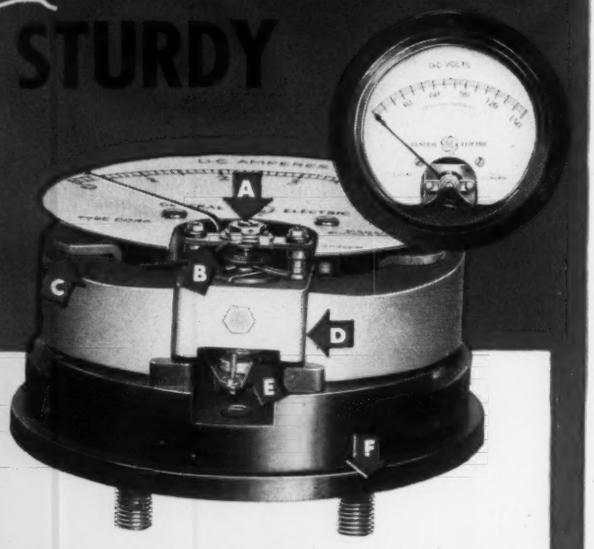
*Please send me complete information on your new push-button station.*

*Name* .....
*Firm* .....
*Address* .....

**GENERAL ELECTRIC**

676-21

# Look Inside and SEE WHY G-E Instruments Are STURDY




WHETHER you use G-E instruments yourself, or build them into your products, sturdy, dependable construction is obviously of utmost importance. Most instruments will operate satisfactorily when new. But it's long-time service that counts—ability to retain accuracy over a period of years.

**That's why we build these features into G-E instruments:**

**A** Sapphire jewels mounted in metal provide a sturdy, low-friction bearing surface.

**B** All parts of the instrument proper are held rigidly together by metal.

**C** The magnet is held securely in place by metal clamps.

**D** Pole pieces are die-cast together—can't change their positions regardless of severity of service

**E** Phosphor-bronze control springs are of finest quality and workmanship.

**F** Strong, molded Textolite base will not warp or change shape.

These are some of the features that help to assure you of long, accurate service even if the operating conditions are unusually severe.

G-E instruments are available in a wide variety of attractive styles and sizes for both a-c and d-c service. For complete information, call the nearest G-E Office or write General Electric, Schenectady, N. Y.

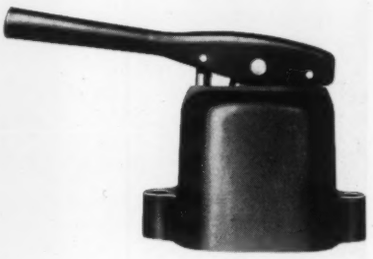
**HEADQUARTERS FOR ELECTRICAL MEASUREMENT**

GENERAL ELECTRIC


wheels with large white figures on black record to 99,999 and repeat.

## Valve Controls Two Cylinders

FOR the control of two individual double-acting air cylinders with only one valve, a double four-way hand-operated air valve has been developed by C. B. Hunt and Son, 1854 East Pershing street, Salem, O. This

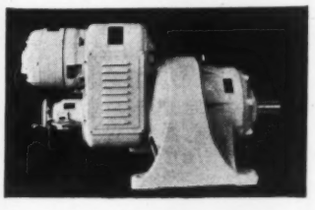


*Double four-way hand-operated air valve is useful where one point of control is needed for two cylinders*

valve's applications include air-operated clamps, fixtures, knives, or any application where it is necessary to have one point of control for two cylinders that lead and lag each other in their respective actions.

## Motor Line Increased

PROVIDING more compact and smaller units, U. S. Electrical Motors Inc., 200 East Slauson avenue, Los Angeles, has added types VEV-GD and VEV-GT to its Varidrive motor line. These motors have double and triple reduction gears for low speed drives. No sub base is required to mount. Further modification of the design



*No sub-base is required to mount motors in new Varidrive line, and Varidrive case may be mounted at any angle*

allows mounting the Varidrive case at any angle with respect to the gear case. If the unit is to be mounted where head room is low, the Varidrive case may be laid over on its side or at any convenient angle.

# Engineering Dept. Equipment

## Whiteprinter on Market

A FAST-printing whiteprint machine in the medium price class has been developed by the Ozalid Corp., Johnson City, N. Y. In the Model F the printer and dry-developer are combined in one compact, lightweight unit which can be easily installed anywhere. A new type high pressure mercury vapor lamp with an output of 40 watts per inch and an active length of 46 inches, gives printing speeds ranging up to 56 inches per minute with uniform light distribution over the entire printing surface. The lamp is guaranteed for 1000 hours. Original and sensitized materials are held in contact with a 4¼-inch diameter glass cylinder which revolves around the stationary high pressure mercury vapor lamp. The glass cylinder, tracing and sensitized material revolve at the same rate of speed with the result there is no slippage or static.

# Plastic Planes

(*Continued from page* 51)

utility of the earlier types are also entirely overcome.

Mention should be made of various other plastic materials employed in plywood construction such as the zinc-chloride, urea-formaldehyde types and the straight urea-formaldehyde resins, both thermosetting in nature. While the phenolics are admittedly better, the urea plastics in their ability to be extended with flour can be made at lower cost.

Another significant feature of bonding with plastic materials which are thermosetting is that the time for cure is a matter of minutes, most veneering jobs being completed in less than one-half hour; usually 3 to 15 minutes. This compares favorably with the earlier processes requiring several hours. Floor space requirements are also considerably reduced.

### High Resin to Wood Ratio

HOT BONDING AT HIGH PRESSURES: While none of the present aircraft manufacturers are hot bonding their wing or fuselage sections under high pressures, the materials prepared in this manner have evoked considerable interest. They may perhaps more strictly be called plastic materials than the other plywood constructions, since a much greater ratio of resin to plywood is present. Developments have been pursued along several channels:

1. Alternating thin (.021-inch) wood veneers with more than one resin film and pressing at pressures up to 1500 pounds per square inch

2. Impregnating spruce or birch veneers with water soluble phenolics, which will penetrate cell walls, and curing under heat and pressure to convert the phenolic plastic to an infusible, insoluble form

3. Impregnating veneers with alcohol soluble phenolics, and laminating under heat and pressures up to 3000 pounds per square inch.

### Strength Proportional to Density

In general, the strength of the plywood appears to be proportional to the density of the finished, compressed material, as well as being dependent on the proportion of the synthetic resin present. Bonding at high pressures is widely practiced in the preparation of laminated plastic materials which have been prepared through impregnation of laminations with phenolic and urea resins, but is still new for the superpressed plywood construction. Tests, however, indicate substantial gains in strength, depending upon the proportion of resin to plywood, the nature of the wood, and the pressure applied. It has been reported that in some instances the increase of tensile strength over the solid wood is as much as 127 per cent, when pressed under pressures of 1500 pounds per square inch.

Gains in the durability of the woods are obtained by methods developed at Forest Products Laboratory. The

**It's DEPENDABLE with This NEW G-E PLUGGING SWITCH**

Frequently, where it is important that a motor stop quickly (in order that another operation can be started promptly, for example), reverse power is applied. The motor comes to rest quickly because of its tendency to run in the reverse direction. This is called "plugging." Naturally, to keep the motor from *running* in the reverse direction, it is necessary that the power be removed at the correct moment. This is accomplished by a plugging switch.

This new G-E switch makes plugging even more generally applicable as a motor-stopping means, for it eliminates variables that were inherent in older types. There is no frictional element to wear and get out of adjustment. There is no oil to sludge or become stiff through age. This new switch requires very little power for its operation (0.12 lb-ft).

You will be interested in this new switch because of its unique principle of operation, which practically eliminates wear and maintenance, and because of the safety features that it affords.

*General Electric, Section C-676-12*
*Schenectady, N. Y.*

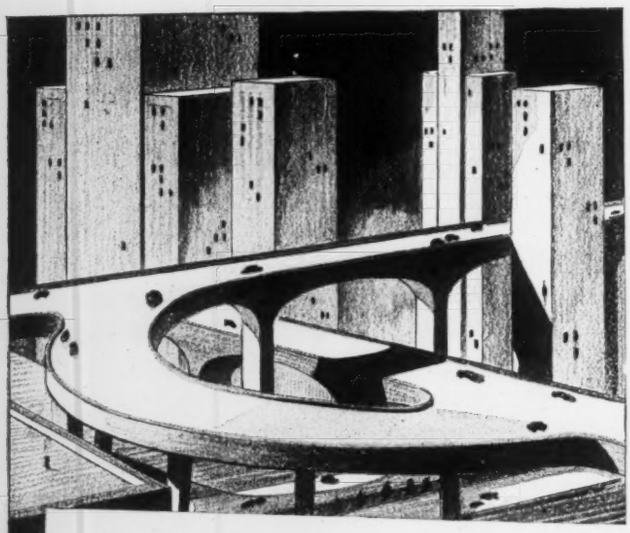
*Please send me your literature describing the new G-E plugging switch.*

*Name* .....

*Firm* .....

*Address* .....

GENERAL ELECTRIC



THE CITY OF TOMORROW WILL START WITH

Micro-Weave All American TRACING CLOTH

Right now Micro-Weave is being used by engineering organizations that are planning Cities, Buildings and Battleships — organizations big enough, thorough enough, smart enough to buy on no man's say so but through tests, trial and use.

For those organizations Micro-Weave is no experiment — they know.

Write for sample testing sheets of Micro-Weave Tracing Cloth — try it yourself.

THE HOLLISTON MILLS, Inc., Norwood, Mass.
*Companion Products: Royal Blue Print Cloth and Photo Cloth.*
BOSTON · NEW YORK · PHILADELPHIA · CHICAGO
ST. LOUIS · RICHMOND

The dispensing roll container is a protection, a convenience and an identification. It keeps the cloth clean — handy brackets attach to desk or table.

impregnation with water soluble phenolics improves the life and resistance of the wood, though gains in physical strength are not appreciable.

The last procedure (3) yields what amounts to a laminated phenolic plastic material, because the identity of the wood laminations is almost lost in the formation of a composite plastic structure reinforced with wood fibers. This material possesses a specific gravity of about 1.3, whereas the plastic woods bonded by the low pressure methods are around .6 to .8. Under the high pressures employed there is a considerable reduction in thickness (spruce compresses considerably more than birch veneers), with the resulting crushing of the cellulose structure. Physical properties, therefore, depend greatly upon the phenolic plastic molecular structure, as in molded and other laminated structures. Nevertheless, when samples of laminated wood veneers prepared by this procedure are examined for creep and cold flow, the influence of the wood grain direction is marked. For example, in the accompanying curves, *Fig.* 1, the creep is much greater when the direction of stress is across, rather than parallel to the wood grains.*

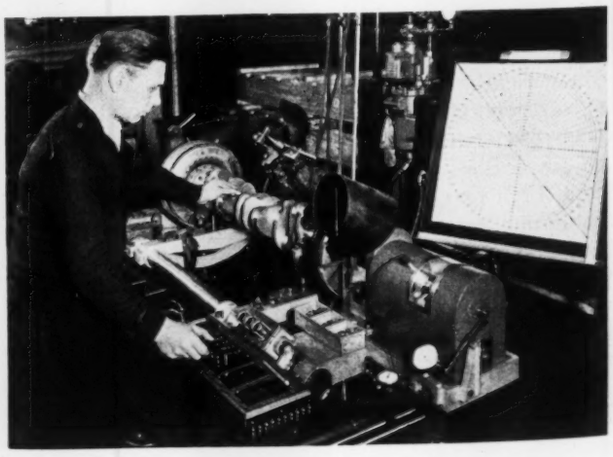
Use of phenolic plastic laminated plywood for airplane construction is bound to increase not only because of these new developments in fabrication which reduce cost but also for the aerodynamic reasons of minimized drag resulting from the elimination of joints and reduced skin friction.

* For method and technique of measuring creep and cold flow see MACHINE DESIGN, Dec., 1939—"Factors Influencing Design"—J. Delmonte.

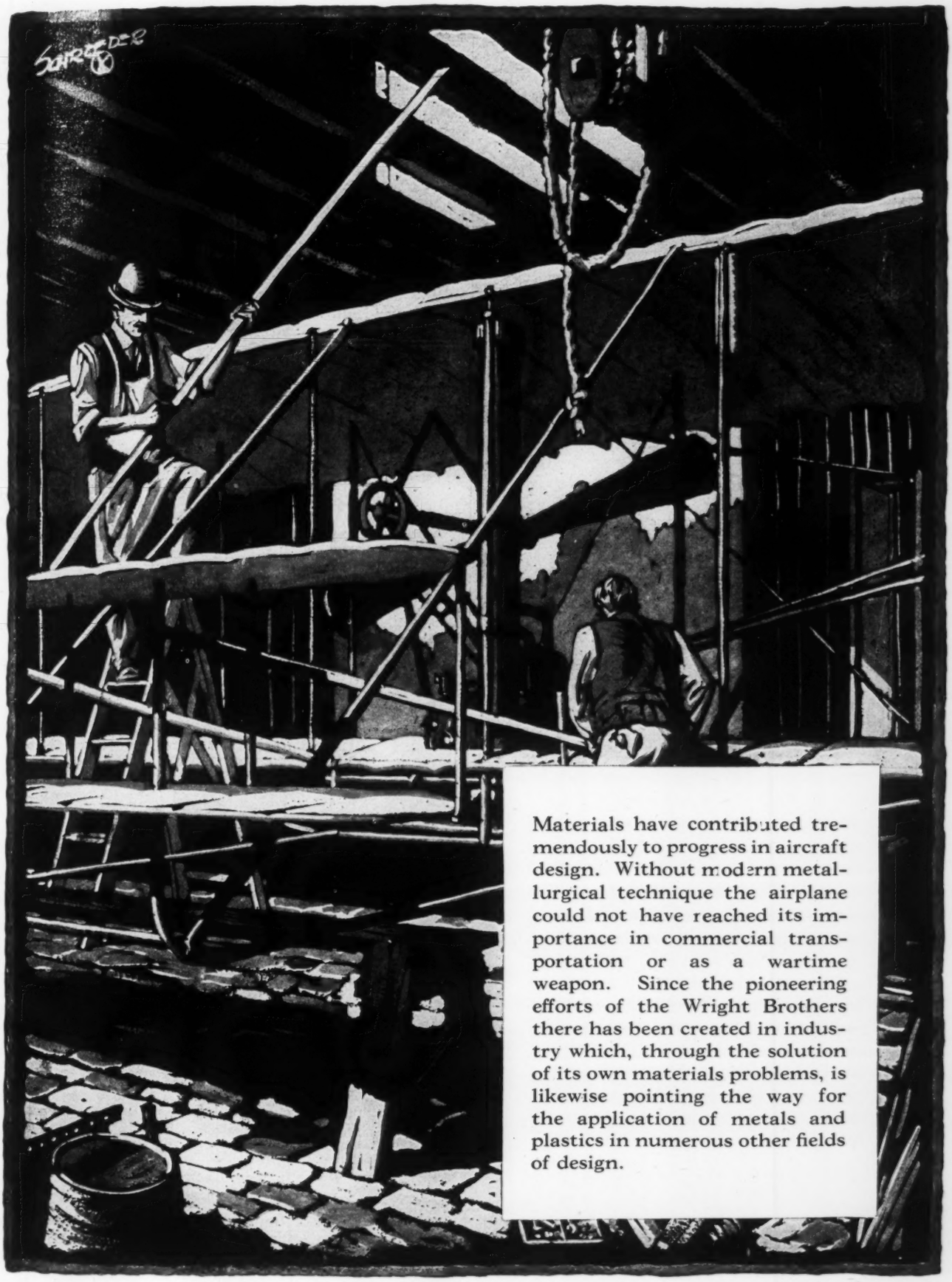
## Balanced Drive Essential

AVAILABLE on the 1941 Chrysler line from the De Soto up is a new semiautomatic transmission, the Simplimatic, which supplements the fluid coupling to provide a unit comparable with Oldsmobile's Hydromatic transmission.

Balancing the Chrysler fluid drive, crankshaft and clutch assembly is all important in the proper functioning of the unit. The chart on the balancing machine



illustrated above provides the operator with a visual indication of the amount and location of any unbalance as well as the necessary weight redistribution for proper dynamic balance.



Materials have contributed tremendously to progress in aircraft design. Without modern metallurgical technique the airplane could not have reached its importance in commercial transportation or as a wartime weapon. Since the pioneering efforts of the Wright Brothers there has been created in industry which, through the solution of its own materials problems, is likewise pointing the way for the application of metals and plastics in numerous other fields of design.

*Wright Brothers and Their Airplane*

# MOTORS

*of Special Design*

TEXTILE loom motors; splash-proof motors for dairies and wet places; vertical motors—these are only a few of the special designs Peerless has available. Peerless builds special motors for grinders, pumps and equipment of all kinds Range of sizes ⅛ to 10 horsepower Send us your drawings and specifications.

THE *Peerless* ELECTRIC CO.
WARREN, OHIO


## Meetings and Expositions

**Oct. 7-11—**

**National Safety Council Inc.** Twenty-ninth national safety congress and exposition to be held in Chicago. Information may be obtained from Paul Jones located at headquarters, 20 North Wacker drive, Chicago.

**Oct. 8—**

**Army Ordnance association.** Twenty-first annual meeting to be held at Waldorf-Astoria, New York. Information may be obtained from the association, Mills building, Washington.

**Oct. 9-11—**

**American Institute of Electrical Engineers.** Middle eastern district meeting to be held in Cincinnati. H. H. Henline, 33 West Thirty-ninth street, New York, is national secretary.

**Oct. 12-19—**

**National Dairy association.** Meeting and exposition to be held at Harrisburg. Lloyd Burlingham, 308 West Washington street, Chicago, is secretary.

**Oct. 13-15—**

**Society of the Plastics Industry.** Annual meeting to be held at Buckwood Inn, Shawnee-on-Delaware, Pa.

**Oct. 14-16—**

**American Gear Manufacturers' association.** Twenty-third semiannual convention to be held at Skytop Lodge, Skytop, Pa. J. C. McQuiston, 602 Shields building, Wilkinsburg, Pa., is secretary.

**Oct. 16-18—**

**Porcelain Enamel institute.** Annual meeting to be held at University of Illinois, Urbana. C. S. Pearce is secretary, 612 North Michigan avenue, Chicago.

**Oct. 17-19—**

**American Society of Tool Engineers.** Semiannual convention scheduled for Cincinnati. Additional information may be obtained from Ford R. Lamb, 2567 West Grand boulevard, Detroit, executive secretary.

**Oct. 17-23—**

**Wire Association.** Annual meeting and exhibition to be held at Carter hotel, Cleveland. Richard Evan Brown, 300 Main street, Rooms 609-13, Stamford, Conn., is secretary.

**Oct. 20-25—**

**American Welding Society.** Annual meeting and exposition to be held at Hotel Cleveland, Cleveland. Miss M. M. Kelly, 807 Riverside Drive, New York, is secretary.

**Oct. 21-25—**

**American Society for Metals.** Annual meeting to be held at the Hotel Statler, Cleveland. W. H. Eisenman is secretary, 7016 Euclid avenue, Cleveland.

**Oct. 25-26—**

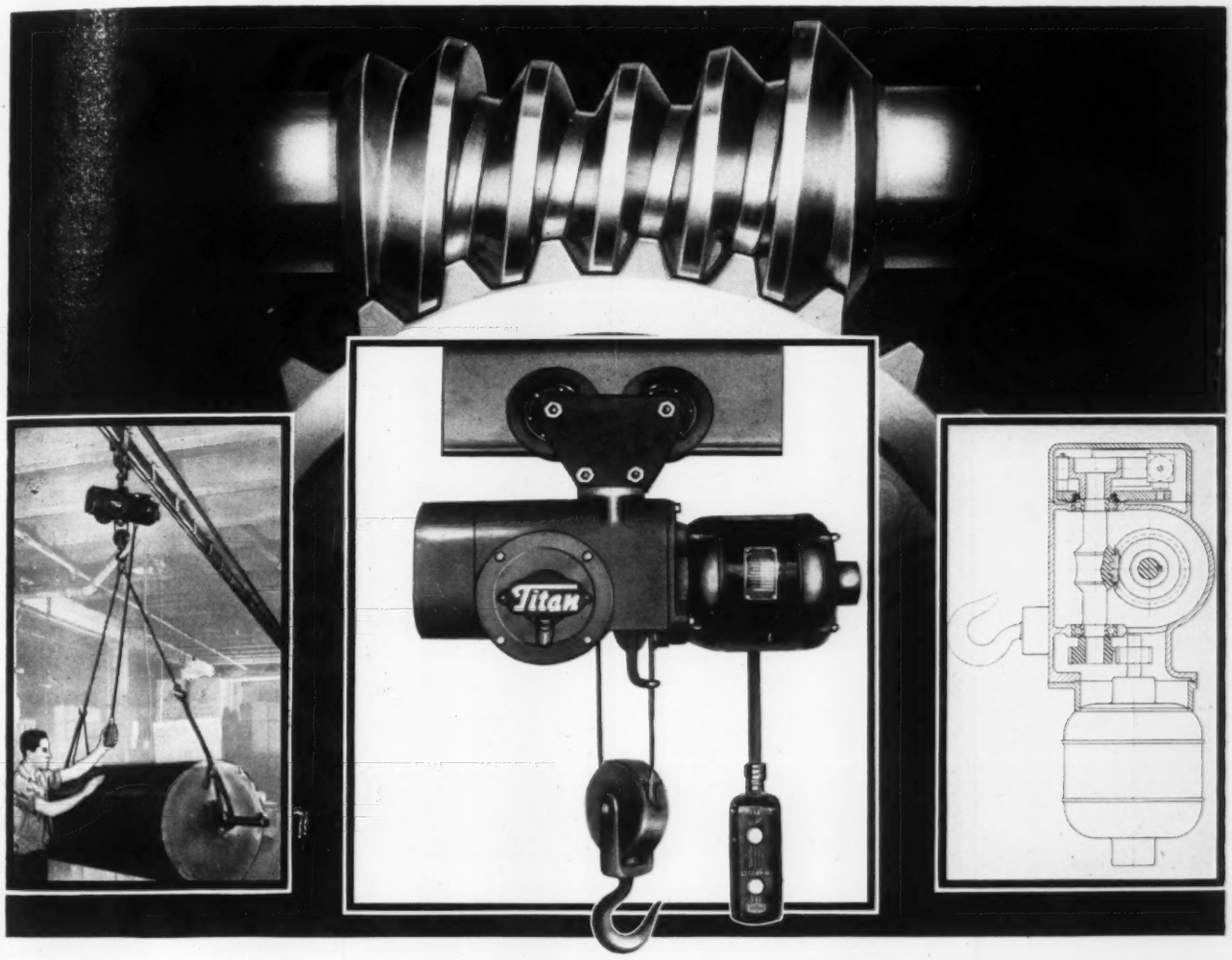
**Foundry Equipment Manufacturers association.** Annual meeting to be held at the Homestead, Hot Springs, Va. Additional information may be obtained from the association, Penton building, Cleveland.

**Oct. 30-Nov. 1—**

**Mechanite Research institute.** Annual meeting to be held at Hotel Schroeder, Milwaukee. Additional information may be obtained from headquarters at 311 Ross street, Pittsburgh.

**Oct. 31-Nov. 2—**

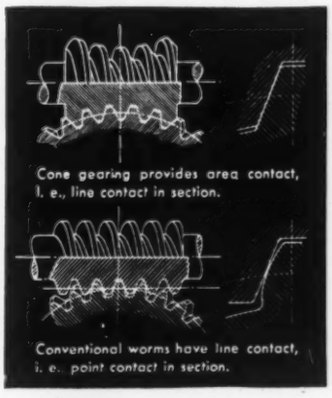
**Society of Automotive Engineers Inc.** National aircraft production meeting and engineering display to be held at Hotel Biltmore, Los Angeles. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.




# *Introducing:* Detroit Hoist's Cone-Geared *Little Titan*

You probably haven't met this hustling hoist as yet, but you'll see lots of them before long—quite likely in your own plant. The latest product of Detroit Hoist and Machine Company, the compact new 'Titan' is a real low cost husky handler for those myriad time consuming light loads (up to 750 lbs.) which pile little expenses into big totals.

Designed to hustle, day in and day out, they are Cone-Driven for maximum dependability, efficiency and life. For Cone-Drive in addition to making the units more compact and eliminating many parts, will carry several times the load—size for size—of conventional worm gearing due to its vastly (up to 30 times) greater area contact.


Cone gearing provides area contact, i. e., line contact in section.
Conventional worms have line contact, i. e. point contact in section.

**CURRENT CONE OPERATING RANGES**
**Ratios . . . Low, 1 to 6; High, 180 to 1**
**Speed . . Low, 1/15 rpm.; High, 30000 rpm.**
**Sizes (C. D.) Low, 5/8 in.; High, 27½ in.**

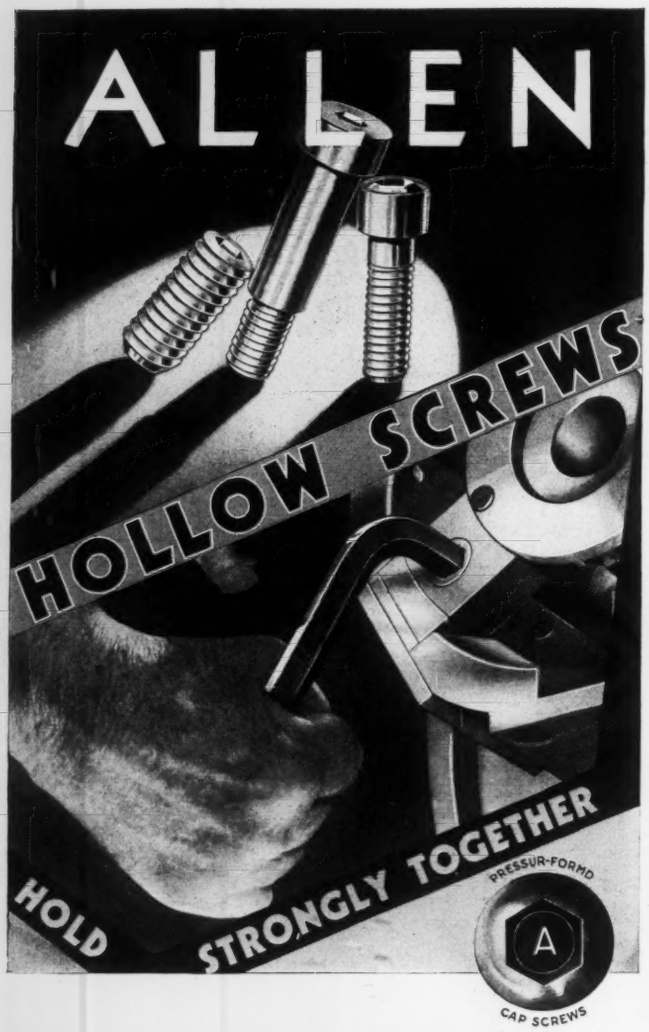
With Cone-Drive you have the highest efficiencies in worm gearing (25% higher, Detroit Hoist estimates) while the worm and wheel characteristic of wearing 'in' instead of 'out' is possessed by no other form of gearing.

For those interested in specifications, the Titan is available in both hook and trolley types, for lamp-socket plug-in or power circuits. Capacities range from 250 to 750 lbs. with hoisting speeds up to 60 ft. p.m. The Cone-Drive has a 2½ in. center distance and 30 to 1 ratio, with the worm shaft running at 1600 r.p.m.

For compactness, reserve capacity, efficiency and long life there is honestly nothing quite like Cone-Drive worm gearing.

*We'll be glad to send you tool charts of readily available sizes, ratios and ratings.*

**CONE WORM GEAR DIVISION** **MICHIGAN TOOL COMPANY**
**7171 E. McNICHOLS ROAD, DETROIT, MICH.**




## Grasp the IN-tangibles too

Engineering departments have every facility for testing hollow screws, but no apparatus for testing the durability of Ideals or the permanence of high standards on the part of the manufacturer.

Let us remember that MEN give a product its character. They even give it *their* character, their integrity, their dependability. In *it* they reflect their own ability to "last".

A mere technical innovation may give temporary prominence to a new product. But consistent progress over many years proves a steadfast purpose to improve and perfect at all costs, — itself a guarantee that no work of today, however good, shall be good enough for tomorrow.

You may take the 30-year record of ALLEN as underwriting the integrity of a product which expresses nothing quite so much as the STRENGTH of our loyalty to your requirements.

*Your local Allen Distributor will oblige with samples and SERVICE.*

THE ALLEN MANUFACTURING COMPANY
HARTFORD, CONN., U. S. A.

# Spring Materials

(*Continued from Page* 49)

in a zero to maximum range may be increased to approximately that obtained on ground and polished steel bars tested in straight torsion.

The data given here apply only to springs operating at normal temperature and assuming that no corrosion of the spring material occurs. In particular it should be mentioned that shot-blasting begins to lose its value at temperatures around 500 degrees Fahr.

Part II. Endurance Ranges in Bending

### Endurance Ranges in Bending

In TABLE V are tabulated the results of fatigue tests on spring materials in bending, tested for completely reversed stress using round specimens or wire. In most cases reported the specimens were ground and polished while in some cases the material was tested in the form of wire so that the surface was in the "as received" condition. It may be noted that in general the ground and polished specimens showed considerably higher endurance limits than did those with the surface untouched.

Similar endurance data for flat and leaf spring materials are given in TABLE VI together with other pertinent data including thickness. The highest values were obtained on thin polished specimens (.006-inch thick) of Swedish spring steel strip. On the basis of these data, the endurance diagram of *Fig.* 2 has been made. This represents what may be expected for good quality leaf or flat spring material in thicknesses around ¼ to ½-inch. Again it may be seen that the ground and polished specimens show considerably higher endurance limits than the others. Higher values may also be expected for high quality thin strip materials.

TABLE VII

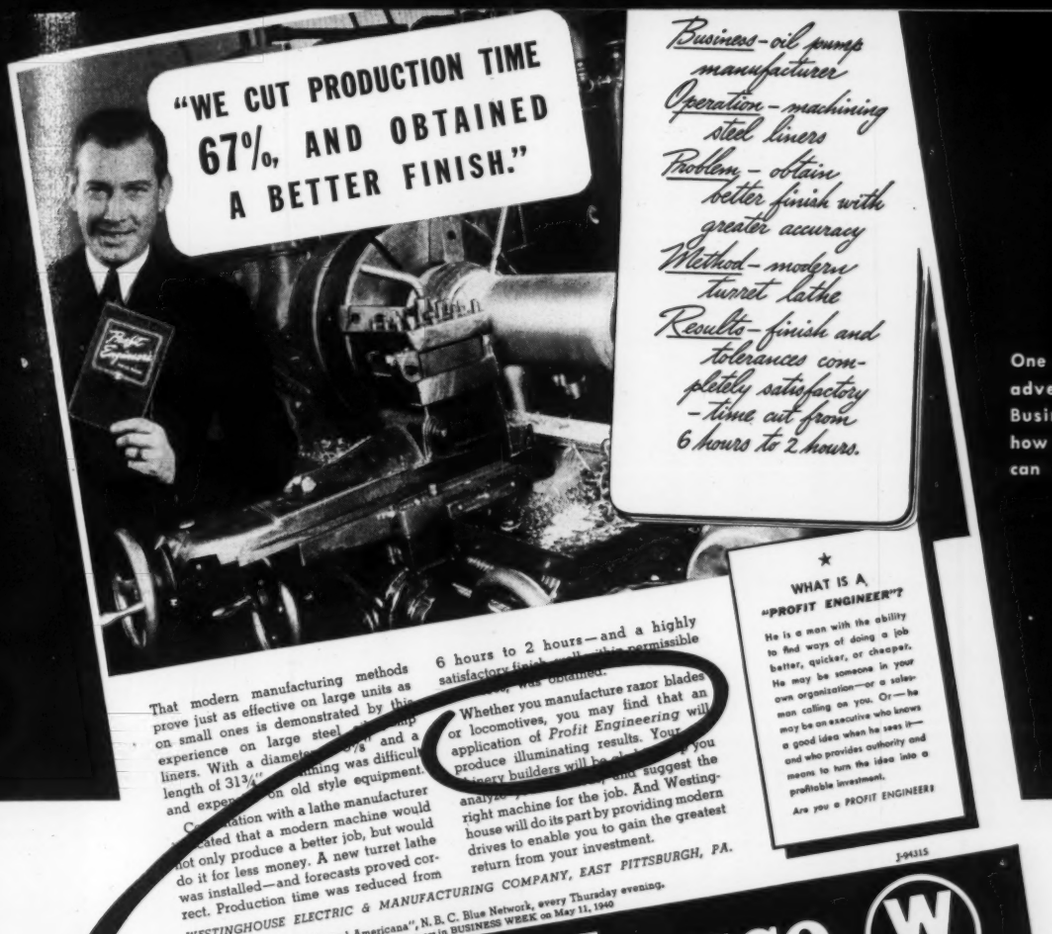
**Endurance Limits of Elliptic Leaf Springs***

| Spring Material | Brinell Hardness | Limiting Range of Stress in Master Leaf lb./sq. in. | Remarks |
|---|---|---|---|
| Cr. Va. Spring Steel ¼" thick leaves | 445 | 3000 to 32000 | Stress concentration effects act to reduce strength. These are due to clamps used and to holes in the springs. |
| .6% Carbon Spring Steel ¼" thick leaves | 349 | 2500 to 46000 | |
| Silico-manganese Steel. ¼" thick leaves | 342 | 4100 to 43000 | |

*Found by Batson and Bradley, Dept. of Sci. & Ind. Research, Spec. Rep. No. 13.

It should be noted that because of stress concentration effects due to holes, notches, clamped edges, etc. the actual endurance limits obtained in leaf or flat springs in general are considerably lower* than those shown in *Fig.* 2. This is shown by the tests on actual elliptic leaf springs reported by Batson and Bradley and summarized in TABLE VII. For these tests, as shown in this table, the limiting range of stress in the

* See author's article in MACHINE DESIGN, May, 1940, for a discussion of methods of taking such effects into account.


"WE CUT PRODUCTION TIME 67%, AND OBTAINED A BETTER FINISH."
Business—oil pump manufacturer
Operation—machining steel liners
Problem—obtain better finish with greater accuracy
Method—modern turret lathe
Results—finish and tolerances completely satisfactory—time cut from 6 hours to 2 hours.

One of a series of Westinghouse advertisements appearing in Business Week, pointing out how industrial modernization can step up production.

That modern manufacturing methods prove just as effective on large units as on small ones is demonstrated by this experience on large steel [illegible] liners. With a diameter [illegible] and a length of 31¾" [illegible] and expensive on old style equipment. [illegible] with a lathe manufacturer [illegible] that a modern machine would not only produce a better job, but would do it for less money. A new turret lathe was installed—and forecasts proved correct. Production time was reduced from 6 hours to 2 hours—and a highly satisfactory finish [illegible] was obtained.

Whether you manufacture razor blades or locomotives, you may find that an application of *Profit Engineering* will produce illuminating results. Your [illegible] machinery builders will be [illegible] you analyze [illegible] and suggest the right machine for the job. And Westinghouse will do its part by providing modern drives to enable you to gain the greatest return from your investment.

*WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, EAST PITTSBURGH, PA.*

Tune in "Musical Americana", N. B. C. Blue Network, every Thursday evening.
This advertisement appears in BUSINESS WEEK on May 11, 1940

J-94315

★

**WHAT IS A "PROFIT ENGINEER"?**

He is a man with the ability to find ways of doing a job better, quicker, or cheaper. He may be someone in your own organization—or a salesman calling on you. Or—he may be an executive who knows a good idea when he sees it—and who provides authority and means to turn the idea into a profitable investment.

Are you a PROFIT ENGINEER?

**Westinghouse**
ELECTRICAL PARTNER OF INDUSTRY

# OR WHETHER YOU BUILD THE MACHINES

In the present emergency, your customers undoubtedly want fast delivery on their machinery orders. Further, they want improved production from these new machines. They've given you a double load to carry.

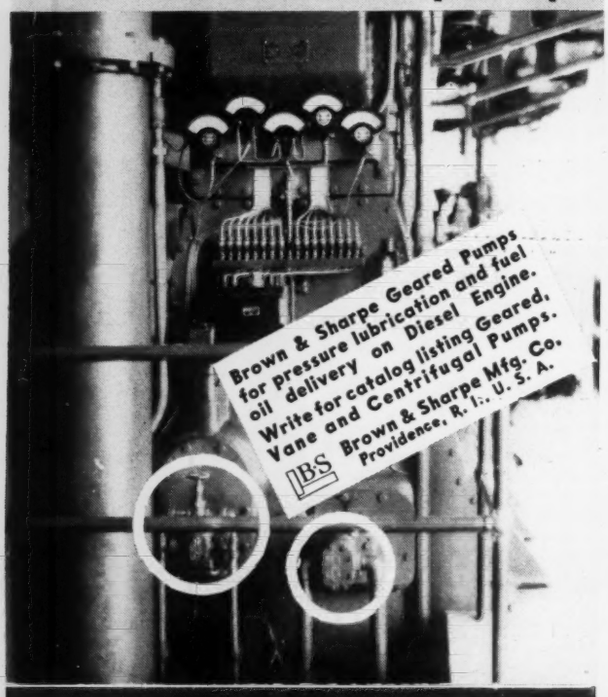
Westinghouse can serve you on both counts. First, by helping you engineer the drives to get the most out of the machines you design. Then, through improved facilities, by making faster deliveries of electrical equipment required.

A call to your local Westinghouse office will bring you fast, capable action.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
EAST PITTSBURGH, PA.

J-94364

**Where Dependability is Vital—You'll find Brown & Sharpe Pumps**


Brown & Sharpe Geared Pumps for pressure lubrication and fuel oil delivery on Diesel Engine. Write for catalog listing Geared, Vane and Centrifugal Pumps. Brown & Sharpe Mfg. Co. Providence, R. I., U. S. A.
BS

BROWN & SHARPE PUMPS

**READY! Another Addition**

to the WHS Line

**. . . the LARGEST COMPLETE LINE of Speed Reducers from any one source**

•

No. 3½ BT (Worm on Top)

Standard ratios 58, 36, 18 and 9 to 1

Torque capacity 140 to 190 inch pounds

For use with ¼ H.P. motor

Write for low prices and **CATALOG No. 140**

*Experienced engineering service . . . Prompt shipments*

**WINFIELD H. SMITH, Inc.**

A Speed Reducer for Every Application

**16 ELTON STREET, SPRINGVILLE, ERIE COUNTY, N.Y.**

master leaf of the spring was only about 30,000 to 40,000 pounds per square inch. For good quality leaf spring steel of this thickness tested without stress concentration but with surface untouched as seen from *Fig.* 2, this range should be around 70,000 to 80,000 pounds per square inch. While the springs tested by these investigators may not have been of the best quality, at least part of this difference is no doubt due to stress concentration effects present in the actual spring.

Values of the limiting stress ranges as given in this article must not be used in actual practice when springs are under repeated or fatigue loading since they represent maximum values as found by test. In design, a margin of safety which depends on the judgment of the designer is always required to take into account other unavoidable uncertainties usually present in most practical applications.

## How Casting Procedure Eliminates Scoring

(*Continued from Page* 56)

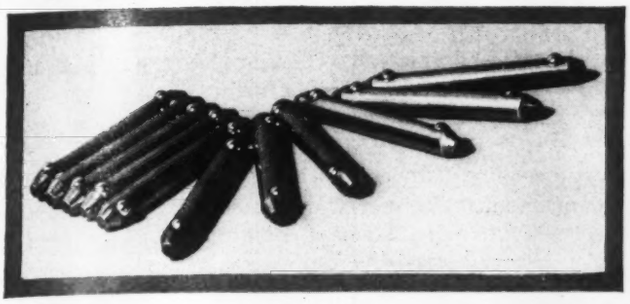
Having found a clue to its cause, the problem now appeared to be one of eliminating or controlling the structure in order to free it of this primary ferrite and insure predetermined satisfactory wear, free from scoring or galling. Before this was possible, however, the reasons or causes for its formation had to be found.

Some investigators believe any given iron has a definite range of cooling rates within which a normal pearlitic structure will be formed. Cooling rates higher than this range tend to form primary ferrite or free cementite; slower cooling rates tend to form secondary ferrite. It was also revealed that primary ferrite areas were found in castings with a carbon content somewhat below normal, and that irons heated to 2850 Fahr. or over would show a greater tendency toward production of primary ferrite than similar irons heated to a lower temperature, even though the pouring temperature remained the same.

In comparing these findings with our practice, we found that we were producing low total-carbon irons (2.70-2.85 per cent) and that we were melting at the higher temperatures of 2840 Fahr. and over, both practices conducive to primary ferrite formation. What to do was a problem since we wished to maintain the high degree of finish and hardness afforded by the low carbon content as well as its flexibility for covering a wide range of casting sections. Also, we had to melt at the higher temperatures to avoid misruns in the lighter sections due to the higher freezing point or shorter life of the low carbon iron. At this stage of the work very little information was available about the control features of this structure, so the only solution apparent was an experimental program.

First experiments consisted of late ladle additions of amorphous graphite on the theory we might possibly

(*Concluded on Page* 102)



# NOT WHAT THEY SEEM!

Far from being bombs, these are brass shafts about an inch long, used to carry perforated tokens, which are slipped on and off over spring-actuated steel balls. These balls with their tiny springs are spun into recesses in the shaft! A nice assembly, indicative of the many phases of "Peck Service." To get better acquainted with this service,

**SEND FOR CATALOG**

Of Peck Springs and Screw Machine Parts and a special technical treatise on how to order springs. Please write on your letter head.

## PECK SPRINGS
**AND SCREW MACHINE PARTS**

**The Peck Spring Co.** **10 Wells St., Plainville, Conn.**

## Thermal Bellows Units for THERMOSTATIC STEAM TRAPS

**CLIFFORD MANUFACTURING CO.**
564 E. FIRST STREET, BOSTON
BOSTON CHICAGO DETROIT LOS ANGELES
PRODUCERS OF BELLOWS EXCLUSIVELY
SERVING AUTOMATIC CONTROL MANUFACTURERS

PUT IN 9 OR 9000
WITHOUT A GAMBLE!
Guarantee
OF HIGHEST QUALITY IN ALL ESSENTIAL CHARACTERISTICS
PARKER-KALON CORPORATION
NEW YORK, N. Y., U. S. A.

## YOU'RE SURE ABOUT SOCKET SCREWS GUARANTEED BY PARKER-KALON QUALITY-CONTROL

You're free of doubt about *every* socket screw that goes into your equipment or product when you use PARKER-KALON. An unequalled quality-control routine, in which Parker-Kalon Socket Screws must satisfy sixteen exacting tests and inspections, eliminates all gamble. Eliminates it by maintaining a new high standard of quality which bars "doubtful" screws that might delay assembly work or fail in service.

WRITE FOR FOLDER AND SAMPLES . . read about the famous Quality-Control Laboratory which guarantees Parker-Kalon Socket Screws. Learn why so many buyers are standardizing on these Screws that have set a new standard of quality. Free samples and local distributor's name will also be supplied. Parker-Kalon Corporation, 192-200 Varick Street, New York.

*Quality-Controlled*

**16-point test and inspection routine covers: Chemical Analysis; Tensile and Torsional Strength; Ductility; Shock Resistance under Tension and Shear; Hardness; Head diameter, height and concentricity; Socket shape, size, depth and centricality; Class 3 Fit Threads; Clean-starting Threads.**

## PARKER-KALON
COLD-FORGED
*Socket Screws*

# After the Victory

There will be a considerable demand in Great Britain for engineering products for Peacetime reconstruction. Under present conditions, mechanical developments are almost entirely directed towards War purposes. Inevitably, there will be urgent and numerous openings for adaptation to British requirements of new equipment that has been developed in U.S.A.

To that end, an old-established, but thoroughly modern, London Company desires to co-operate and undertake the making and marketing of any class of American medium engineering product. High commercial and banking references: strictly confidential negotiations . . . Patentees and Makers please write:— Box No. 133, Machine Design, Penton Building, Cleveland, Ohio.

●

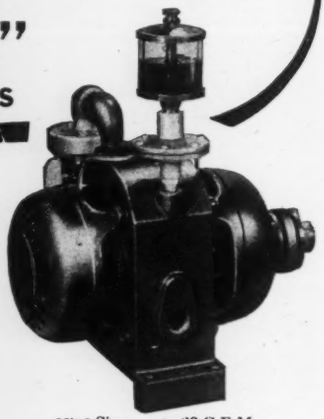


*When You Need*

**VACUUM PUMPS**

*FOR THE "TOUGH JOBS"*

**SPECIFY "GAST" ROTARY AIR PUMPS**



Scores of manufacturers of filling equipment, oil furnaces, laboratory suction-pressure apparatus, printing frames, etc., etc. use Gast Air Pumps as *standard equipment* because of these features!

**FORCED - AIR COOLING**—Eliminates complicated water systems . . . lowers temperatures and oil consumption . . . assures longer life.

**AUTOMATIC LUBRICATION**—*Positive* provision of oil where and when needed . . . *without* causing loss of pressure or vacuum. Visible oil supply.

**DIRECT DRIVE**—Assures positive alignment . . . eliminates end thrust . . . reduces power loss.

**COMPACT**—Delivers more air per pound of weight and H.P. used.

**SIMPLICITY**—No gears, springs or reciprocating parts . . . automatic take-up for wear of vanes.

**ADAPTABILITY**—Can be used as either vacuum or pressure pump.

Nine Sizes—1 to 23 C.F.M. Vacuum to 28" Pressures To 30 Pounds

***WRITE NOW*** For Complete Engineering Catalog and Performance Data Of Gast Air Pumps. Also Information On Manufacturers Discounts. Address: **Gast Mfg. Corporation, 107 Hinkley St., Benton Harbor, Mich.**

**GAST VACUUM PUMPS**


(*Concluded from Page* 96)

induce flake formation by "seeding" or the introduction of graphite nuclei. This treatment resulted in a definite improvement and *Fig.* 4 illustrates the graphite formation of this iron. This shows a medium graphite flake evenly distributed without a distinct pattern arrangement. The etched specimen showed practically all pearlite with a small trace of secondary ferrite. No primary ferrite was present.

Our next experiments consisted of supplementing the amorphous-graphite additions with ferrosilicon in varying proportions. Being a graphitizer, the silicon would affect the cooling rate and act as a mild deoxidizer at the same time. These combinations had their merits and produced equally good results.

Following the same lines we used a commercial compound of silicon and carbon in varying percentages. This also produced good results in that we were able to keep the primary formation at the cast surface. After using this treatment for a sufficiently long period to build up some data, we adopted several combinations of ferrochromium and ferrosilicon.

The chromium, a carbide-forming element, and the silicon, a graphitizer, enabled us to change the cooling rates of the base composition. Our work on this phase of treatment was not extensive but we obtained sufficiently good results to warrant further work.

## Depth Can Be Controlled

While the ultimate aim is to be able to establish conditions which will completely eliminate or minimize the formation of primary ferrite, we feel that sufficient data have been accumulated to enable an effective control of the depth of formation. This control feature gives every indication of being the difference between a casting which may score and one which will not score since, if all the primary ferrite is removed in the machining operation, we have a normal structure at the wearing surface.

To substantiate these findings an extensive wear test has been conducted, results of which are shown in *Fig.* 5. Each curve represents the average of twelve readings and is read as weight loss per hour. Interpretation of these curves is that the greater the weight loss, the poorer the wearing qualities.

The curve designated *"G* on 1106," is the result of a wear test on an iron *"G"* with excessive primary ferrite, and "1106" a normal bed iron without any primary ferrite. The weight loss is 195 milligrams in one hour, which would indicate poor wear or possibly a severe case of scoring. The other curves show from 21 to 33 milligrams for the first hour and represent irons with a normal type of structure free from primary ferrite, and also represent structures of machines giving satisfactory performance free from scoring.

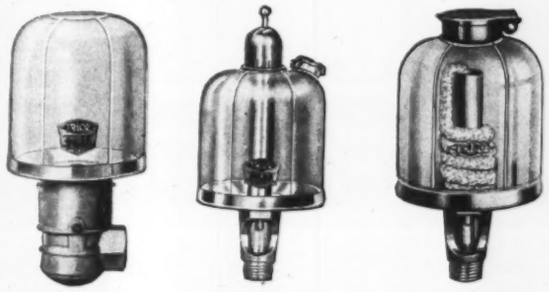
As a result of these tests we feel that, with the proper degree of control both in the foundry and in the laboratory, cast iron with its inherent high damping, castability, machinability, and wear-resistance properties, now represents an ideal material for wear resistant castings like those in machine tools.

# OILERS

**ALL SIZES**

Glass and Unbreakable Types

TRICO visible automatic lubrication is the ultra-modern way to stop waste and failures caused by old-fashioned trust-to-luck hand oiling methods.



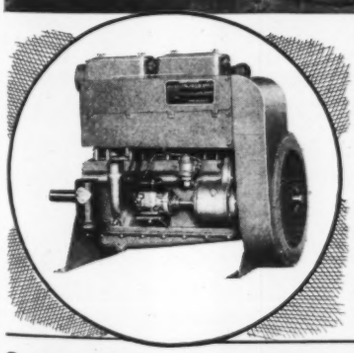
OPTO-MATIC GRAVITY FEED WICK FEED

LEVOMATIC DRIP-DROP OPTO-MATIC

TRICO REG. U.S. PAT. OFF.

WRITE FOR BULLETINS

TRICO FUSE MFG. CO., Milwaukee, Wis.
In Canada: IRVING SMITH LIMITED, Montreal



290 leading equipment manufacturers use WISCONSIN air-cooled power. They have found it to be the safest — most economical — the protection which they need to safeguard the reputation of their machines.

**Our engines fit all requirements • 1 to 35 H.P.**

**Wisconsin Motor Corporation**
MILWAUKEE, WISCONSIN, U.S.A.



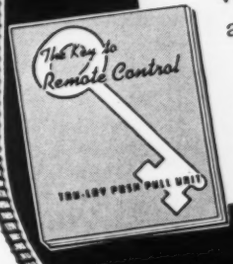
*Operators* are More EFFICIENT
*Machines* are More PRODUCTIVE

with **TRU·LAY PUSH-PULL CONTROLS**

● Operators work with more confidence and efficiency when their machines respond more readily to controls that may be operated at most convenient points.

**TRU·LAY Push-Pull Controls** are alert and positive in operation. They hold any position to which they are set. There is none of the noise, sloppiness, uncertainty and bother that come with rods, links, bell-cranks, pins and other devices. **Push-Pulls** require no adjustment.

They are easily installed, because they are quickly snaked around any obstructions.




**THIS BOOKLET WILL HELP YOU**
Write for "The Key to Remote Control." It contains valuable information on the control of mechanisms.

*RETURN THIS COUPON FOR COMPLETE INFORMATION*

ACCO TRADE MARK

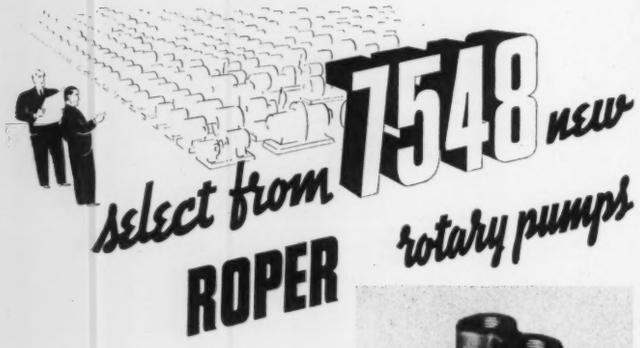
**AMERICAN CABLE DIVISION**
**American Chain & Cable Company, Inc.**
**230 Park Avenue, New York, N. Y.**

**Please send complete information on TRU-LAY PUSH-PULL CONTROLS.**

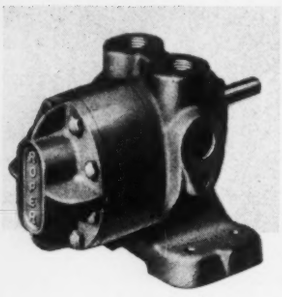
*Name*.....

*Address*.....

*City*.....*State*.....



Select from 17548 new ROPER rotary pumps



Roper offers you 8 series of pumps with capacities ranging from one to 1000 gallons per minute . . . pressures up to 1000 pounds per square inch . . . speeds up to 1800 r.p.m. . . . 21 different drives and mountings . . . 8 different piping arrangements . . . a pump for every purpose in the design best adapted to fulfill your particular needs with the highest degree of efficiency.

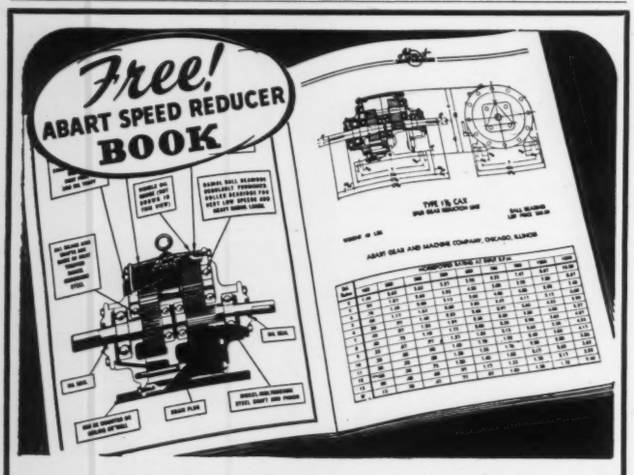
Send us your specifications and get detailed information on the new improved line of Roper Hydraulically Balanced Pumps.

*Write for Catalog 932 or see our catalog in Sweet's*

**GEO. D. ROPER CORP., ROCKFORD, ILLINOIS**

ROPER *Rotary* PUMPS






*Select the Right Reducer From This Book*

In it you'll find the correct answer to your speed reducer problem quickly. There is information on ratings and other essential data that will help you select the most efficient type and style. Use your company letterhead and write for this *free* catalog today.

**GEARS**

Quality gears made to meet most requirements. No stocks. Cut to B/P or specifications only. Let us estimate.

Abart GEAR AND MACHINE CO.
MANUFACTURERS OF
Speed Reducers & Gears
4621 WEST 16TH ST. CHICAGO ILLINOIS


# Materials in Compressor Design

(*Concluded from Page* 43)

tube type in which the cooling water passes through the tubes. Baffles for inducing the air or gas to cross and recross the tubes are bakelite plastic so that, at the points where the tubes pass through the baffles, possible axial movement of the tubes due to thermal expansion or contraction will not cause wear.

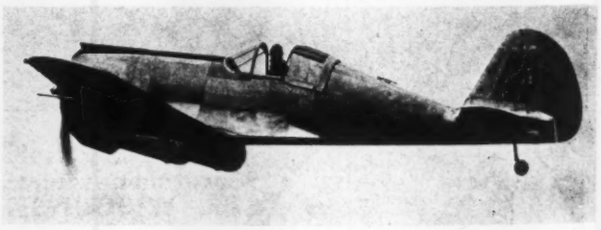
In order to obtain the maximum rate of heat transfer compatible with necessary strength, the tubes are variously made of muntz or admiralty metal fastened into copper bearing steel or muntz metal tube sheets.

In this necessarily somewhat restricted survey of the materials used in reciprocating compressors, ample evidence is given that the design of this equipment from the materials standpoint has been conducted in full awareness of the many engineering materials available to the modern machine designer. The finished machines indicate the careful consideration given materials cost consistent with operating and fabricating requirements and exemplify, further, an essential viewpoint of the engineer in the design and materials specifications of commercial machines.

The editors wish to thank the Chicago Pneumatic Tool Co. and the Ingersoll Rand Co. for their assistance in supplying information and illustrations used.

## Climbs Mile a Minute

Designed to attack invading enemy bombers between the time when the alarm is sounded and before they reach their objective, the Curtiss-Wright Interceptor-Fighter shown in flight climbs well over a mile a minute and is the fastest climbing plane in the world according to its builders, the St. Louis Airplane division



of the Curtiss-Wright Corp. This plane is the first of a production order now being built for a foreign government.

The Curtiss-Wright interceptor fighter is powered by a 1000-horsepower Wright Cyclone engine and is equipped with four machine guns which fire through the propeller. According to military experts, it is more effective than antiaircraft batteries in combating high flying enemy bombers because of its mobility and the rapidity with which it may be directed against an attack by the use of radio communication with ground and air forces. The plane weighs only 4250 pounds fully loaded.

# SpeedWay

Worm Drive
Back Geared
FLEA POWER MOTORS
**110 VOLT**
AC, DC,
or Universal

**Motorize your products or make them Automatic with SpeedWay Motors**

DEPENDABLE 110V MINIATURE MOTORS . . . types that exactly meet the requirements of a hundred different jobs . . . A.C., D.C. or Universal, Cased or skeleton types, with or without back gears . . . any speed or torque. Hundreds of thousands in use.

LOW COST . . . produced in great quantities by modern volume production methods, these reliable little motors are surprisingly inexpensive.

TECHNICAL SERVICE . . . state your problems, we'll give you our answer with prices, quotations, and possible delivery dates.

ANY QUANTITY . . . 1 or 1,000,000 on short notice—sold singly, in dozens or thousands.

*Write for Motor Sheets*

SPEEDWAY MFG. CO., 1858 So. 52nd Ave., Cicero, Ill.



# KOH-I-NOOR
## Drawing Pencils

**10c**
EACH

Manufactured in U. S. A.

**KOH-I-NOOR PENCIL COMPANY, INC.**
373 Fourth Ave.
NEW YORK, N. Y.



# New OHMITE Catalog and Manual

## 96 Pages of Valuable Data on the Use of Resistors, Rheostats, Tap Switches

***It's new . . . different***—an invaluable guide for design and application engineers, production managers, and purchasing departments! Catalog and Engineering Manual 40 is a complete handy reference on the use of resistors, rheostats, tap switches, chokes and attenuators in products and special applications—in the control of motor speed, of heat and light, of signal and supervisory circuits—in instrument rooms, maintenance and production—in laboratory and electronic equipment.

***Helps work out resistance problems***—gives handy reference tables and dimensional drawings, practical engineering data, manual of resistance measurements—covers the most complete line—tells about stock units and special units for industrial, R.F. and precision applications.

***It's yours without charge***—you can get this complete handy reference easily—just clip this coupon to your letter or write us on company stationery. Catalog 40 will be sent to you at once.

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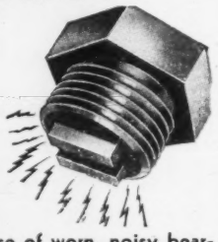
*Be Right with*
OHMITE
RHEOSTATS · RESISTORS · TAP SWITCHES

# MAGNETIZED DRAIN PLUGS

*Stop Excessive Wear*

**TO BEARINGS AND GEARS**



Abrasive metal particles resulting from a chipped gear, a worn cam or other moving parts, are the most common cause of worn, noisy bearings. Eliminate 90% of this trouble with Magnetized Drain Plugs. A powerful, permanent magnet attracts and holds these metal particles. Prevents excessive wear and noise. Prove this for yourself without obligation.

**FREE TEST OFFER**

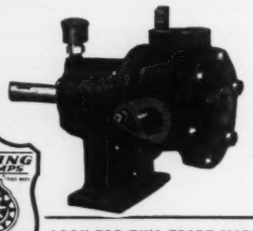
**Free Sample plugs for testing in your product, furnished on request. Write today.**

LISLE CORPORATION, Box 1003, Clarinda, Iowa

# WAR ON WASTE

**WITH VIKING ROTARY PUMPS**

- Compact in design, Viking requires only a minimum of room for quick installation. NO WASTE SPACE!
- Built specifically for the job it is intended to do, Viking performs with greater efficiency, greater accuracy. NO WASTE MOTION!
- Employing only 2 moving parts, Viking operates longer at less cost. NO WASTE POWER!
- Bulletin 1100-32 gives you just the real facts and specifications on Viking Coolant Pumps for Machine Tool service. NO WASTE READING!



LOOK FOR THIS TRADE MARK THE SIGN OF A GENUINE VIKING

**VIKING PUMP CO.** CEDAR FALLS, IOWA.


# Business and Sales Briefs

FREDERICK E. BARTH has become associated with National Motor Bearing Co., Oakland, Calif., as industrial sales manager. Although he will make his headquarters at the Oakland plant he expects to spend considerable time throughout the east and middle west in consultation with designers. He was connected in an executive capacity for many years with Graton & Knight, Worcester, Mass.

♦

M. J. McKeever has been appointed manager of the Atlanta branch, Crucible Steel Co. of America, New York. He has been in the Atlanta office, 381 Whitehall street, since 1927.

♦

Springfield Electric Motor Co., Springfield, O., has been appointed a distributor for the General Electric Co., Schenectady, for wire and cable products.

♦

Ohio Gear Co., Cleveland, announces its appointment as national distributor for the products of the Browning Mfg. Co., Maysville, Ky. A complete line of V-belts and multiple pulleys will be carried.

♦

Reliance Electric & Engineering Co., Cleveland, is opening a sales office in Houston, Tex., with Frank A. Denison Jr. as district manager. He has been a member of the sales engineering staff in the Detroit office since early 1937. Tinkham Veale, of the sales service department of Reliance in Cleveland, succeeds Mr. Denison in Detroit.

♦

Appointment of the Sintes Sales Engineering Co., New Orleans, La., as representative in Louisiana, southern part of Mississippi, and the Mobile section of Alabama, is announced by the Universal Gear Corp., Indianapolis.

♦

Three promotions in the eastern sales force of New Departure division, Bristol, Conn., are announced. Ralph O. Wirtemburg, manager of the New York office, has gone to the main office in Bristol as eastern sales manager, a new post. Francis B. Wasley, in charge of the Philadelphia office, was shifted to succeed Mr. Wirtemburg in New York; and Mark Goedecke, service engineer in the Bristol office, was made chief of the Philadelphia office.

♦

Huie Simmer Co., 103 Thomas building, Dallas, Tex., has been appointed district sales representative in Oklahoma for the complete line of Trico Fuse Mfg. Co., Milwaukee.

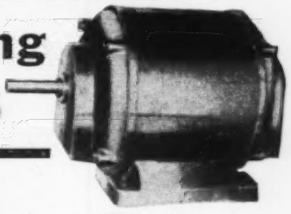
♦

Office and factory additions of the Bantam Bearings Corp., South Bend, Ind., are nearing completion and will be ready in about a month. The new additions, the fourth in six years, are necessitated by increasing volume of quill, roller and ball bearing sales. About one-third more floor space will be added to present factory area. Space now occupied by offices will become the new physical and metallurgical laboratories, appreciably augmenting the facilities and equipment of Bantam's present laboratory.

♦

Appointment of C. W. Sweeney as supervisor of operations on the Pacific coast is announced by the Bunting Brass & Bronze Co., Toledo. He will have charge of activities of Bunting offices and warehouses in Los An-

# VALLEY
## Ball-Bearing MOTORS



*The Choice of Leading Design Engineers*

. . . . *because BETTER MOTOR DESIGN* has been the consistent aim of Valley Electric Corporation engineers throughout the years. The Valley Ball-Bearing Electric Motor of today offers definite buyer-appeal in efficiency and economy to the purchasers of your equipment. That is why prominent design engineers are incorporating Valley Ball-Bearing Motors in their plans.

Consider the importance of these five outstanding features when you order your next motor. (1) No Dead Spots. . . . (2) Efficient and Ventilated Winding. . . (3) 40° C. Maximum Temperature Rise. . . (4) Squirrel-Cage Welded Rotors. . . (5) Ball Bearings.

**DRIP PROOF—SPLASH DESIGN**

Valley Ball-Bearing Motors are designed to meet operating conditions where hazards of liquids, chips etc., dropping into the motor, are involved. Motors are protected against this as well as against normal splash conditions.

*Ball-Bearing Motors ½ to 75 Horsepower*

**Write for full information. Free Bulletin 14.**

Valley ELECTRIC

**VALLEY Electric Corp.**

4221 Forest Park Blvd. • St. Louis

# MILLIONS OF CONTACTS WITHOUT 1 CENT FOR REPAIRS

. . . yes, up to fifteen million and more!

Why this sure fire Limit Switch stamina?

Because Snaplock is built by a machine tool manufacturer *with* machine tool ruggedness, and is guaranteed for any type of normal circuit operation.

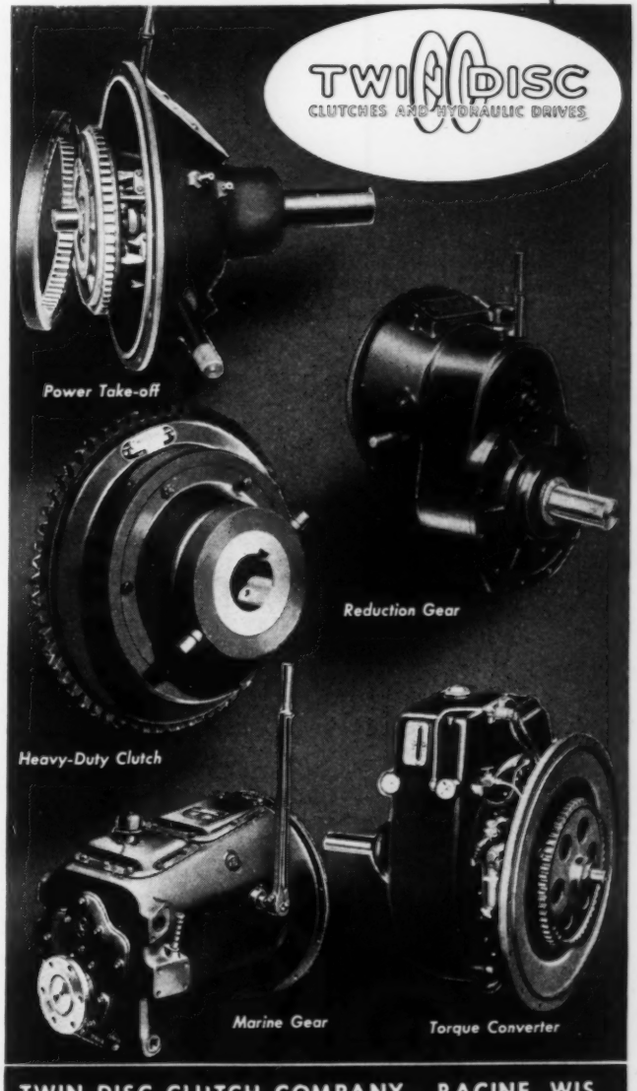
Adopted by more than 200 manufacturers as the standard built-in switch and used by thousands of others as a replacement item.

Write for "STARTLING FACTS" folder. It tells the whole story and offers a FREE TEST. How can you lose?

**THE NATIONAL ACME CO. • Cleveland, O.**

# INCLUDING "Extras"

● The wide preference for Twin Disc products—clutches, power take-offs, reduction gears, hydraulic drives and marine gears—comes, not alone from their mechanical adaptability . . . the exceptional care used in material selection and specification, the professional craftsmanship that distinguishes each interchangeable part . . . but from the farsightedness and advanced engineering, the almost prophetic awareness of approaching changes, the constant looking ahead to the work that tomorrow's power transmission equipment will demand. These are the things that give Twin Disc products their "extras" in value. That's why we say: "Twin Disc Clutches are built for the job they will be called on to do, not merely to fit some machine of which they are an important part."



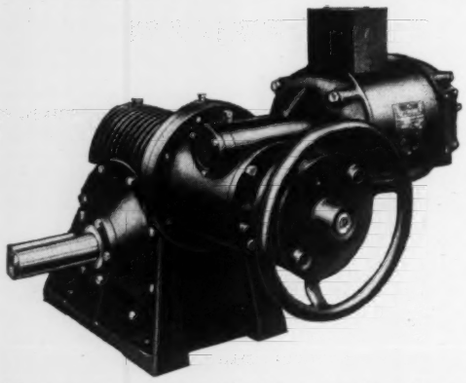

**TWIN DISC CLUTCH COMPANY., RACINE, WIS.**

# Janette

**MOTORIZED SPEED REDUCERS**

**FOR SLOW SPEED DRIVES**

**1/50 TO 10 H.P. . . . . .08 TO 1140 R.P.M.**



Reliable operation is one of the outstanding features of Janette speed reducers. Thousands of these machines are driving the vitally important electric voltage regulators and combustion control equipment in many of the largest power plants.

The Janette motors used for this severe service, must operate 24 hours each day without fail; be able to reverse 20 or more times per minute and have windings which will not burn out if the motors are stalled.

It will pay you to use these reliable Janette reducers for driving your slow speed machines.

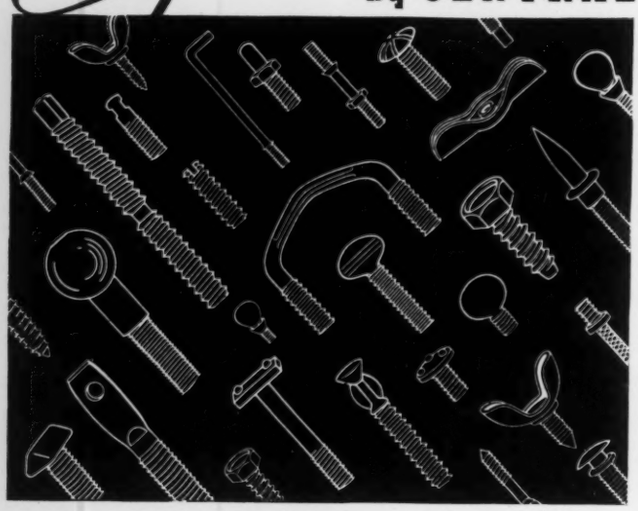
MAY WE SEND YOU OUR CATALOG?

**Janette Manufacturing Company**

556-558 West Monroe Street Chicago, Ill. U.S.A.



# Specials by CENTRAL



★ Gain the economy of cold upset and rolled-thread specials, accurately manufactured in productive quantities at Central. Our engineers are ready to give you full cooperation in the development of special products. Write today.

**CENTRAL SCREW COMPANY**

**3509 SHIELDS AVENUE • CHICAGO, ILLINOIS**


geles at 240 West Eighteenth street, San Francisco at 277 Seventh street, and Seattle at 1722 Broadway. Walter Gardner, in charge of the San Francisco warehouse for the past seven years, will be Mr. Sweeney's assistant. Additions will be made to personnel in each city.

♦

Chain Belt Co., Milwaukee, announces the removal of its Minneapolis office to 1645 Hennepin avenue, from 808 LaSalle avenue. Much more space and increased service facilities are available at the new address. R. X. Raymond is Minneapolis district manager.

♦

R. L. Hibbard, formerly of the New York office, has been appointed to the merchandising sales staff of the Detroit office of Cutler-Hammer Inc., Milwaukee. He has been with the company since 1936, following graduation from Cornell university.

♦

American Stock Gear Co., 646 West Washington boulevard, Chicago, is building a new plant in the Clearing Industrial district. The factory will be one-story, with 30,000 square feet of floor space. At present the firm makes gears from ⅛-inch to eight feet in diameter but the increased facilities will enable it to handle gears as large as 12 feet in diameter. Spiral bevel gears will be offered at a price competitive with the straight tooth type bevel gear.

♦

Stearns, Perry and Smith, 51 Chardon street, Boston, has been appointed district agent for the Boston territory by Janette Mfg. Co., Chicago.

## Research Publications

*Frog-Leg Windings for Direct Current Generators and Motors*, by C. S. Siskind. The author has attempted to show that the "frog-leg" winding, principles of which he discusses, is really a combination of the two well-known types—lap and wave—operating in parallel. Unique feature of the frog-leg construction, however, is the possibility of embodying one lap coil and one wave coil into a single unit, an arrangement permitting a saving of space in the slots and in the labor in winding. The resulting winding is equalized 100 per cent and requires no equalizer connections. Lap and wave sections divide the total load current equally because the same cross-sectional area is employed in both, and there are exactly as many parallel paths in one as in the other. Published by the Engineering Experiment station, Purdue university, Lafayette, Ind.

*A Study of Food-Mixer Motor Performance*, by C. S. Siskind. This is a study of particular interest to all designers working with machines utilizing series, or universal, motors, and it is especially attractive because it was made by a neutral researcher. Nine mixers were selected, all fairly well-known and having a relatively wide price and power-input range, and the electrical and mechanical characteristics of the motors were determined. Torque-speed curves are given for each motor and are valuable for study in the light of the comments appended to each. In conclusion, nine characteristics are listed which a mixer should embody and many of these characteristics are those common to all small machines. They include a relatively large number of speed adjustments; a minimum temperature rise of the motor for sustained heavy loads; reasonably close agreement between alternating and direct current speed characteristics; inclusion of a radio interference eliminator; reduction of gear noise to a minimum. Published by the Engineering Experiment station, Purdue university, Lafayette, Ind.

# BLUE Devil

The ARISTOCRAT of SOCKET SCREWS

*Try our service on your special sizes.*

1—Cold-formed heads—unimpaired continuity of fibres.

2—Tensile strength 215-225,000 lbs. per square inch.

3—Precision formed hexagon socket with true sides and no taper.

4—Chamfered edge knurled to facilitate assembly.

Blue Devil Cap Screws are unbelievably tough, and are heat treated in electrically controlled furnaces. Send for catalogue and samples.

*Nothing too large - Nothing too small for*

SAFETY SOCKET SCREW CORPORATION

4447 N. KNOX AVE., CHICAGO, ILLINOIS

# PRECISION BUILT!

RUTHMAN

## GUSHER COOLANT PUMPS

● Like all fine tools Ruthman Gushers are precision built to withstand constant, hard use. That is why leading machine tool builders specify Gushers as standard equipment. End your pump worries today. Write for engineering data and specifications.

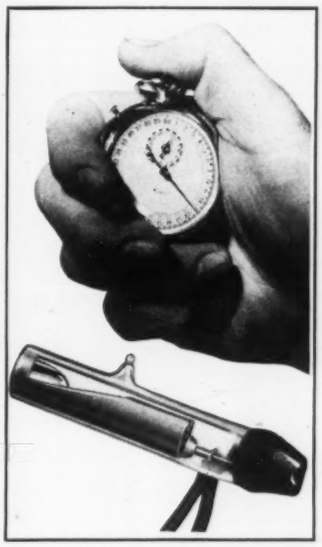
All Gusher models are ball - bearing, quiet, and safely handle grit and abrasive - loaded coolant. Write today.

THE RUTHMAN MACHINERY CO.

540 E. FRONT ST., CINCINNATI, OHIO

LARGEST EXCLUSIVE BUILDERS OF COOLANT PUMPS

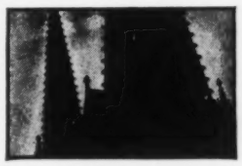
# *moving mountains*



**...OR TIMING** an electric circuit . . . these amazing G-E KON-NEC-TORS do the job. They provide wear-proof, trouble-free and maintenance-free contacts in *all* electrical equipment circuits. The G-E Delayed Action KON-NEC-TOR, shown to the left, now available at a new low price, can be used to delay the opening or closing of circuits at pre-determined time intervals, within close tolerances. And whatever your needs may be, there's the right size and type of G-E KON-NEC-TOR for the job.

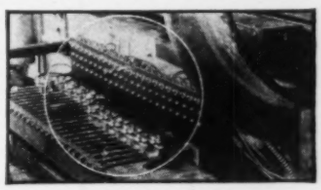
**FOR EXAMPLE**

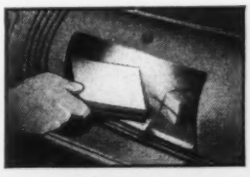
**1** This 1250-ton "mountain-mover" is equipped with G-E KON-NEC-TORS as nerve centers in the patented leveling system which controls its mammoth hydraulic jacks. Because of their special construction, these KON-NEC-TORS may be operated efficiently millions of times.



**2** One of nation's largest churches depends upon G-E KON-NEC-TORS to ring the largest bells in the carillon tower, also the quarterly-hour chimes. The contacts are always clean, and maintenance is eliminated.

**3** 24 G-E KON-NEC-TORS make and break the electrical currents that control the color patterns on this floor printing machine. The operation is always fast and dependable.





**4** Automobile manufacturers will find the new small size G-E KON-NEC-TOR useful for lighting glove compartments automatically as the door is opened. For further information, write or wire to address given below:

NELA SPECIALTY DIVISION, LAMP DEPT.

GENERAL ELECTRIC

*410 Eighth Street, Hoboken, N. J.*

# NEW MACHINES—
## And the Companies Behind Them

*(For illustrations of other outstanding machinery see Pages 58-59)*

### Air Conditioning
Turbo-compressor, York Ice Machinery Corp., York, Pa.

### Dairy
Electric automatic milk vendor, The Venderlator Mfg. Co., Fresno, Calif.
Quart-size bottle washer, Heil Co., Milwaukee.
*Bottle washer, The Liquid Carbonic Corp., Chicago.

### Domestic
*Frozen food locker, Motor Products Corp., N. Chicago, Ill.
Stoker, Hutchinson Mfg. Co. Inc., Norristown, Pa.
Boiler burner unit, York Oil Burner Co. Inc., York, Pa.
Radio-phonograph, Galvin Mfg. Corp., Chicago.
*Stoker, Will-Burt Co., Orville, O.

### Dry Cleaning
*Washer-extractor, The Band Box Corp., St. Louis.

### Food
*Butter print scale, Toledo Scale Co., Toledo, O.
Coffee grinder, Jabez Burns & Sons Inc., New York.
Electric oven, The Petersen Oven Co., Chicago.
Electric slicer, U. S. Slicing Machine Co., La Porte, Ind.
*Mixer, American Machine & Foundry Co., New York.

### Industrial
Dust collector, American Foundry Equipment Co., Mishawaka, Ind.
Jaw crusher, Diamond Iron Works Inc., Minneapolis.
Jaw crusher, Iowa Mfg. Co., Cedar Rapids, Ia.
Forging and heat treating furnace, Mahr Mfg. Co., Minneapolis.
Glass working lathe, Eisler Engineering Co., Newark, N. J.

*Illustrated in pictorial center spread, Pages 58-59.

### Marine
Engines, Caterpillar Tractor Co., Peoria, Ill.

### Materials Handling
Hydraulic elevating truck, Lyon Iron Works, Greene, N. J.
Locomotive, General Electric Co., Schenectady, N. Y.
Crawler crane, Lima Locomotive Works Inc., Lima, O.
Feeder, Pioneer Engineering Works, Minneapolis.
Miner, Chain Belt Co., Milwaukee.
Vibrating type conveyor, Ajax Flexible Coupling Co., Westfield, N. Y.
Crane, The Cleveland Crane & Engrg. Co., Wickliffe, O.
Fork truck, Elwell-Parker Electric Co., Cleveland.

### Metalworking
Filing machine, Grob Brothers, Grafton, Wis.
Electric bench grinder, Independent Pneumatic Tool Co., Chicago.
Portable cutting machine, Harris Calorific Co., Cleveland.
Broaching machine, American Broach & Machine Co., Cincinnati.
High-speed production marker, Quality Die Co., South Chicago, Ill.
Portable air grinder, Pneumatic Tool Co., Chicago.
*Threading machine, Landis Machine Co., Waynesboro, Pa.

### Office
Ten-key calculator, Allen Calculator Inc., New York.
Liquid duplicator, The Duplicopy Co., Chicago.
Folding machine, Multistamp Co., Norfolk, Va.

### Packaging
Vibratory feed weigher, Triangle Package Machinery Co., Chicago.
Bag closing machine, Union Special Machine Co., Chicago.
Container sealing machine, A-B-C Mfg. Co., Quincy, Mass.

### Painting
Paint conditioner, Landon P. Smith Inc., Irvington, N. J.

### Paper
Pulp washer, Oliver United Filters Inc., New York.

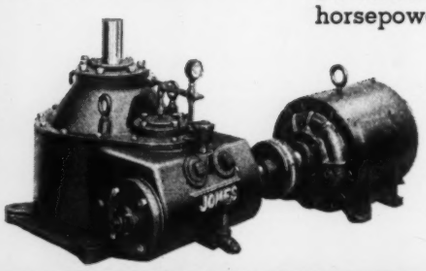

*For* driving agitators, mixers and similar equipment—

**JONES WORM-HELICAL SPEED REDUCERS**

HERE is a line of machines that fills a long felt need for double reduction units of the fully enclosed type to be used for agitators, mixers, etc. requiring a vertical shaft drive.

Many of these Jones units have established excellent performance records in a wide variety of service. As a result of that experience a complete standard line has been developed covering 15 standard ratios ranging from 40 to 1 to 250 to 1 for all common motor speeds and a wide range of horsepower ratings.

• This Jones Worm-Helical Speed Reducer on a lacquer agitator is typical of the wide range of services for which these drives can be used such as ore roasters, pulp tank mixers, furnaces, bending rolls and similar applications.



The new Jones Bulletin No. 75 covers complete details on these new Worm-Helical Speed Reducers, with rating tables, dimension diagrams, torque charts and other application information. We shall be pleased to send you a copy.

**W. A. JONES FOUNDRY & MACHINE CO.**
4413 Roosevelt Road, Chicago, Illinois

**Jones**

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS • PULLEYS
CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES • ANTI-FRICTION
PILLOW BLOCKS • FRICTION CLUTCHES • TRANSMISSION APPLIANCES

# Hanna Cylinders

## They'll work for you a thousand ways!

**PNEUMATIC**
*up to 100 lbs. operating pressure*

WHEREVER you need controlled power to push or to pull, raise and lower, through rods, levers or toggles — your best bet is a cylinder — a *Hanna Cylinder!* They'll do that work with dependable efficiency at a cost that is really low. Maintenance? — you can practically forget it.

Hanna Cylinders have replaced manual effort in hundreds of operations — they have simplified all types of machine control and actuation in every kind of equipment. Results have always demonstrated improvement and economy. You'll be able to use them too . . . in the machines you build or in your plant operations.

There is a standard model Hanna Cylinder, air or hydraulic, to fit your problems. Put them to work for you.

*Write for Low Pressure Cylinder Catalog No. 228—or Hydraulic Cylinder Catalog No. 229.*

**HYDRAULIC**
*up to 1500 lbs. operating pressure*

**HANNA ENGINEERING WORKS**
1772 ELSTON AVENUE • CHICAGO, ILLINOIS

| Air and Hydraulic | Air and Hydraulic | Air |
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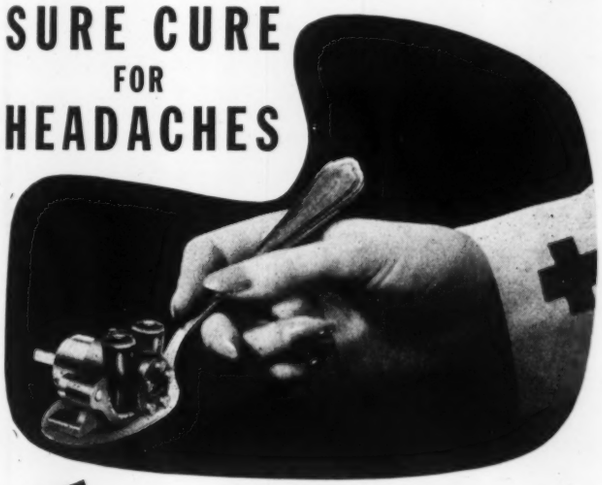
# SURE CURE FOR HEADACHES



Here's one way to prevent pump service "headaches." Specify Tuthill Pumps for dependable, carefree performance. A type for every purpose, including Tuthill Stripped Pumps for direct incorporation into the design of your machine.

Write for Tuthill General Catalog today.

**TUTHILL PUMP COMPANY**
941 EAST 95TH STREET, CHICAGO, ILLINOIS

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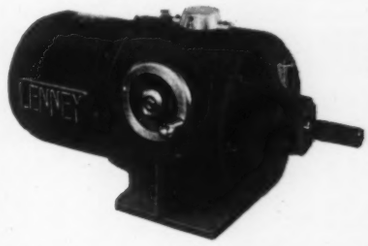
# LENNEY
# *VARIABLE SPEED*
## TRANSMISSION

*With speeds instantly adjustable to a fraction of an R.P.M.*

● Regardless of load imposed on the output shaft, speed to which the Lenney Variable Drive is set is its running speed. Shock loads or overloads cannot alter speed. An automatic pressure regulating clutch is actuated by amount of load on output shaft.

Handwheel by which speed changes are obtained is conveniently located on the side of the unit, thus providing instant control at the touch of a finger. Other methods of control can be furnished, however.

Its compactness readily adapts it to design of any machine for which a self-contained, variable speed drive is sought. Smooth, clean lines enhance the streamline appearance of the machine on which it is installed.




The Lenney Variable Speed Transmission is available in either unit type or motorized with an integral 220/440-volt, 60-cycle, 3-phase motor within range of ⅛ to 7½ horsepower. Write for further details.

**THE LENNEY MACHINE & MANUFACTURING CO.**
WARREN, OHIO

### Printing

Composing room saw, American Type Founders Sales Corp., Elizabeth, N. J.

### Processing

Machine for proportioning liquids into liquids or gases, D. W. Haering & Co. Inc., Chicago.

Double ribbon mixer, H. K. Porter Co. Inc., Pittsburgh.

Mixing machine, Prater Pulverizer Co., Chicago.

Laboratory mixer, Mixing Equipment Co. Inc., Rochester, N. Y.

Oil expeller, V. D. Anderson Co., Cleveland.

Furnaces, Pyrolectric Co., Trenton, N. J.

Tempering and drawing furnace, Despatch Oven Co., Minneapolis.

### Pumping

Vertical turbine pumps, Pomona Pump Co., Pomona, Calif.

Pump, Lehman Engineering Co., Newark, N. J.

### Restaurant

Deluxe fryer, Star Mfg. Co. Inc., St. Louis.

### Road

Road spray truck, Littleford Bros., Cincinnati.

### Rubber

Bale cutter, Farrel-Birmingham Co. Inc., Ansonia, Conn.

Heating and circulating unit, John Royle & Sons, Paterson, N. J.

Extra heavy 84-inch mill, Farrell-Birmingham Co. Inc., Ansonia, Conn.

Bale cutter, Spadone Machine Co. Inc., New York.

### Tanning

Beaming machine, The Turner Tanning Machinery Co., Peabody, Mass.

### Testing

Testing machine for aircraft, U. S. Electrical Motors Inc., Los Angeles.

### Textile

Warp knitting machine, Whitin Machine Works, Whitinsville, Mass.

Stainless steel slack washer, The Textile-Finishing Machinery Co., Providence, R. I.

*Doubler, Foster Machine Co., Westfield, Mass.

Lap-proof separator, H. J. Hofford Silk Appliances, Philadelphia.

Random dyeing machine, Roanoke Mills Inc., Roanoke, Va.

8-color printing machine, Textile Finishing Machinery Co., Providence, R. I.

Blending feeder, Whitin Machine Works, Whitinsville, Mass.

Cloth inspection machine, Curtis & Marble Machine Co., Worcester, Mass.

Automatic start control machine, Champion Machinery Co., Joliet, Ill.

High-speed warper beamer, Robert Reiner Inc., Weehawken, N. J.

### Welding

Arc welder, General Electric Co., Schenectady, N. Y.

Portable arc welder, The Hobart Brothers Co., Troy, O.

Spot welding machine, Eisler Engineering Co., Newark, N. J.

Arm type spot welder, Acme Electric Welder Co., Huntington Park, Calif.

Butt welding machine, Eisler Engineering Co., Newark, N. J.

Heavy-duty projection welder, The Federal Machine & Welder Co., Warren, O.

Gas-engine-driven arc welder, The Hobart Brothers Co., Troy, O.

Diesel arc welder, Lincoln Electric Co., Cleveland.

### Woodworking

Ball bearing planer and matcher, Newman Machine Co. Inc., Greensboro, N. C.

Portable heavy-duty edge belt sander, Ekstrom, Carlson & Co., Rockford, Ill.

Disk sander, Skilsaw Inc., Chicago.


MACHINE DESIGN

*A Penton Publication*

PENTON BLDG. • CLEVELAND, O.

■ **THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS** . . . MACHINE DESIGN is devoted exclusively to design problems and development of ideas for engineers and executives in the field of machinery manufacture.

Over 36,000 design engineers and executives in more than 7900 machinery manufacturing plants read MACHINE DESIGN regularly.

The first publication to devote its editorial content exclusively to discussion of machinery design problems, MACHINE DESIGN remains the only one whose contents, distribution and readership are concerned alone with the design and redesign of machinery.



THE POWER BEHIND A CYCLONE!

Far greater than the wind velocity attained by the most violent cyclone is that delivered at the discharge by the NOVO powered Niagara Cyclone Duster. The Niagara Sprayer and Chemical Company manufacture their machine for orchard protection. They power them with Novo model CW industrial engines because this type of service demands the heavy-duty features found only in Novo engines. 1½ to 22 H.P.

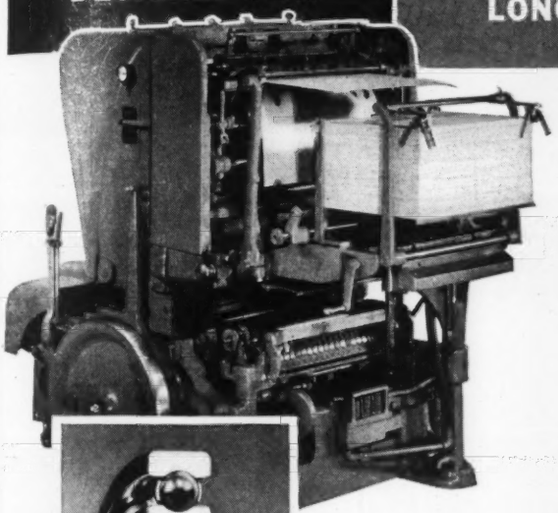
See these features for yourself. Send for literature. There's no obligation.

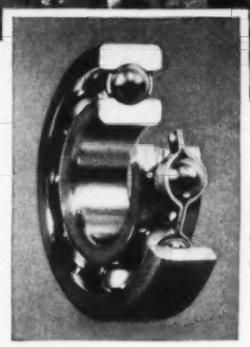
NOVO ENGINE COMPANY LANSING, MICHIGAN

NEW MIEHLE VERTICALS DESIGNED FOR

HIGHER SPEED GREATER ACCURACY LONGER LIFE

# Use BCA Ball Bearings





*BCA Single Row Radial Bearings like this are used in the new V-50 Miehle Verticals.*

SINCE its introduction in 1922 the Miehle Vertical has become the most popular high-speed automatic press in the printing plants of America.

Eighteen years' experience in building "Verticals" has led to many improvements. The new Model V-50 illustrated is more accurate and rugged and even faster than ever before.

Eighteen years has taught Miehle a lot about ball bearings too. BCA Ball Bearings are used at a number of key points.

There are good reasons why Miehle and other machinery manufacturers use BCA Ball Bearings. We will welcome the opportunity to go into those reasons with you, personally. We hope such an interview will be to our mutual benefit.

BEARINGS COMPANY OF AMERICA, LANCASTER, PENNA.

# BCA

RADIAL • ANGULAR CONTACT • THRUST

## BALL BEARINGS

LEIMAN BROS. Patented Rotary Positive

# AIR PUMPS

## Pressure—Vacuum—Gas Pumping AIR MOTORS

**Take up their own wear**
**No packing or tips on the wings**

The built-in one-year-lubrication of Leiman Bros. Rotary Positive Air Pumps is the new wool yarn packed bearing which holds in suspension enough lubricating oil for one year's service, strained and purified.

The continuous unbroken cylinder surface makes these always noiseless air and gas pumps doubly quiet. The air enters and emerges in a sidewise course through the by-pass in the cylinder head.

This means a smooth, glassy-like cylinder surface, easy operation and saving in power.

The advantage gained by this simple construction is that the wings in constant operation will wear in conformity with the inner cylinder wall and become smooth and glassy like as well as case-hardened in use, and maintain a perfect fit and positive air pressure, even after long continued usage.

Get Free Information.

**LEIMAN BROS.** 152-3K Christie St. NEWARK, N. J.

*Makers of good machinery for 50 years*

# Gear Specialties

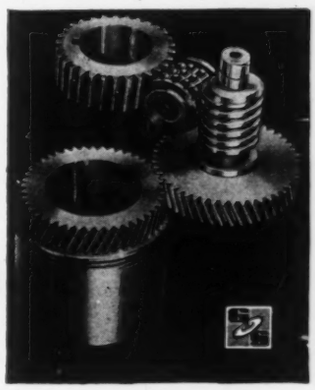
*14 to 96 D.P.*

SPURS

SPIRALS

HELICALS

BEVELS



*14 to 96 D.P.*

RACKS

RATCHETS

WORM-

GEARING

—such as these, and numerous others, are the logical product of a skilled organization with a deft 'feel' for *precise* work . . . Note the *combination* Worm-gear, rotating as a Gear on one side and as a Worm on the opposite side.

*Made to order only—No stock—No catalog*

# Gear Specialties

2670 W. MEDILL AVE. Phone Humboldt 3482

CHICAGO